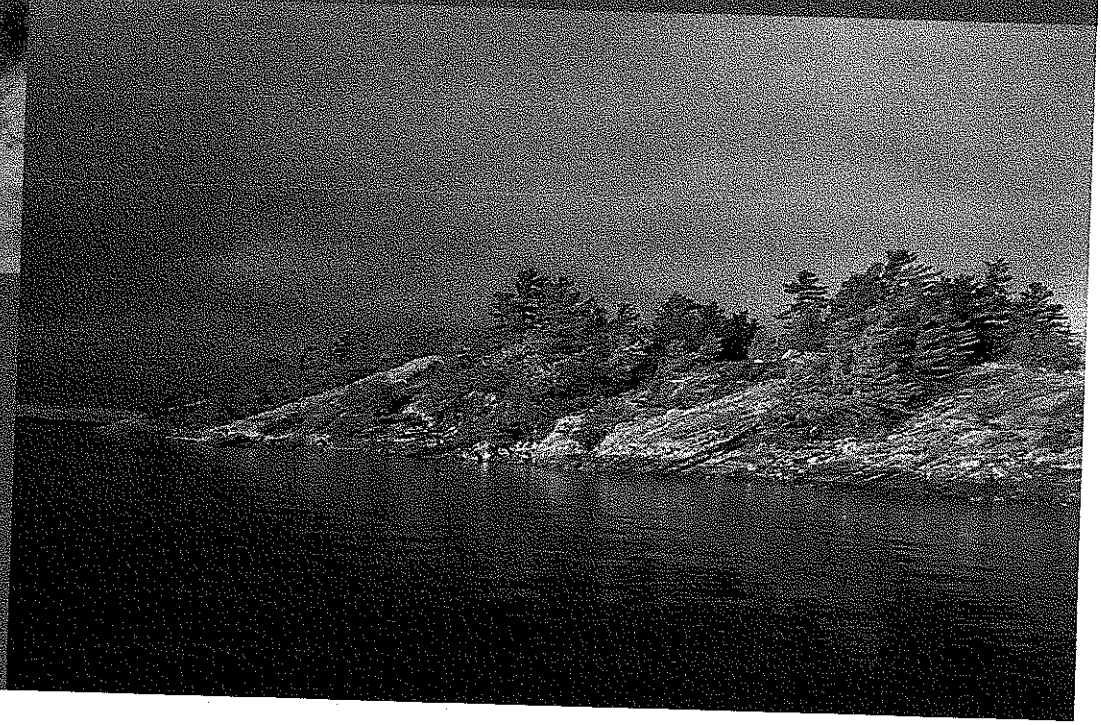
Lake Huron Binational Partnership



ACTION PLAN

Table of Contents

Executive Summary

Section 1: Executive Summary

In 2002, the Binational Executive Committee formally endorsed the formation of a Lake Huron Binational Partnership in order to coordinate environmental activities in the Lake Huron basin. The United States Environmental Protection Agency, Environment Canada, Michigan's Departments of Environmental Quality and Natural Resources and Ontario's Ministries of Environment and Natural Resources form the core of the Partnership by providing leadership and coordination. However, a flexible membership is being promoted which is inclusive of other agencies and levels of government, Tribes/First Nations, non-government organizations and the public on an issue-by-issue basis.

The approach to Lake Huron differs from the Lakewide Management Plans (LaMPs) of Lakes Superior, Michigan, Erie and Ontario in that there has been no systematic assessment of beneficial use impairments, identification of causes, definition of critical pollutants, determination of chemical sources and loadings, and release of a report for comment. The alternative approach focuses on areas of obvious importance, tackles these as priorities in the first action plans, and will expand over time to include other activities that investigate the less severe or obvious issues in the lake. Three priority issues - contaminants in fish and wildlife; biodiversity and ecosystem change; fish and wildlife habitat - were given priority for immediate action while other issues will be tracked and added as the Partnership pursues this process of updating and expanding activities over time.

Actions in Areas of Concern or resulting from specific local priorities are also part of the Partnership's agenda. These actions, which are being managed domestically, include the continued efforts at Saginaw Bay, monitoring of Spanish Harbour's recovery and science based investigations of bacterial and algae fouling of beaches along the south-east shore of the lake. Other Lake Huron concerns include: low water levels, botulism, cormorant populations, blue-green algae blooms in Georgian Bay, aquaculture, emerging contaminant concerns and global climate change.

This 2004 Action Plan provides information on priority issues, trends, goals, research, monitoring, on-the-ground activities and future needs. Consistent with an adaptive management approach, it is not fully comprehensive, but will be expanded and added to over time. Contaminant trends in fish and wildlife have been summarized, current knowledge of changes in the fish community, threats to aquatic life and habitat have been outlined along with proposed draft environmental objectives for fisheries management. More detail on any of these topics can be obtained from source documents and fact sheets developed by the Partnership. The Action Plan section itself highlights the activities already underway and planned over the short term (2 years) and future efforts over the long term (5 years). These actions are geared towards improving knowledge, understanding function and change, monitoring trends, and restoring, rehabilitating and protecting the Lake Huron ecosystem.

Introduction

Section 2: Introduction

2.1 The Lake Huron Basin

The Lake Huron drainage basin is unique in the Great Lakes system, both as the lake in the middle of the Great Lakes and due to its abundance of shoreline habitat. Lake Huron has over 30,000 islands and, as a result, has the longest shoreline of any lake in the world. Its expansive open-lake waters, large watershed area and relatively undisturbed nearshore areas support a high diversity of aquatic and riparian species of importance to the Great Lakes region.

The Lake Huron watershed is home to about 2.5 million people. Both sides of Lake Huron have relatively low human population densities. As a result Lake Huron retains much of its historic fish and wildlife habitat. Saginaw Bay, Georgian Bay and the North Channel still support some of the most extensive high quality coastal habitat in the Great Lakes.

The U.S./Canada border divides Lake Huron almost in half. The Canadian portion of the Lake, including Georgian Bay, is wholly in the Province of Ontario. The U.S. portion is located entirely within the State of Michigan. The drainage basin on the Ontario side (86,430 square kilometers or 33,500 square miles) covers twice the area, has approximately five times the shoreline, and roughly 300,000 fewer residents than in Michigan.

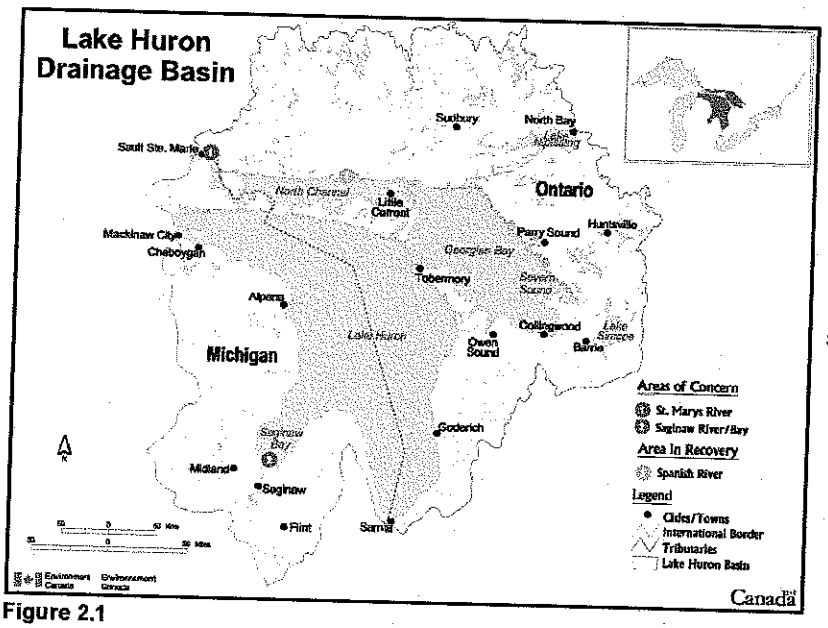


Figure 2.1

The Lake Huron basin contains no major metropolitan areas. The largest urban centers in the basin are Sudbury and Sarnia on the Ontario side and Saginaw and Bay City on the Michigan side. With populations under 100,000, these urban areas are relatively small compared to urban areas in the more populous Great Lake basins. The Lake Huron basin is heavily forested in the northern portion and then becomes increasingly agricultural in the south with its urbanized areas along the southernmost portion of the lake. Much of southern part of the Huron basin is devoted to intensive cultivated field crops and, beef and dairy farms, particularly in the "thumb" area of Michigan, along the Bruce Peninsula and the southeast shore of the main basin. Mining of limestone, nickel, uranium, copper, platinum and gold has been an important activity in the northern portion of the Lake Huron basin. Though residential land use makes up a small percentage of total land use, much rural development has occurred along the shoreline. In the past 20 years there has been increasing development pressure for cottages and year-

General Lake Huron Facts

Length (miles)	206
Breadth (miles)	183
Average depth (feet)	195
Maximum depth (feet)	750
Volume (cubic miles)	850
Water surface (square miles)	23,000
Watershed area (square miles)	51,700
Shoreline length (miles w/islands)	3,827
Retention time (years)	22.6
Total population	2,694,154
Michigan	1,502,687
Ontario	1,191,467
Islands	more than 30,000

Source: Environment Canada/U.S. Environmental Protection Agency, 1996

Figure 2.2

round retirement properties. Undoubtedly, the next 20 years will bring more as urban populations grow and the retired population increases.

In 1987, four Areas of Concern (AOCs) were identified in the Lake Huron basin in addition to the St. Marys River. Within the basin two AOCs, Saginaw Bay, Michigan, and Spanish Harbour, Ontario remain. The causes of impairment within the AOCs are being addressed, and habitat, fish and wildlife populations, and environmental quality are recovering. Canada and Ontario have recognized Spanish Harbour as an "Area in Recovery" where all remedial actions have been implemented and the environment will take some time to respond and the goals to be achieved. Severn Sound, Ontario was delisted as an AOC in 2003 and the Collingwood Harbour AOC, also in Ontario, was delisted in 1994. The St. Marys River is being addressed through a binational process.

Lake Huron is the third largest freshwater lake in the world in terms of area, and the sixth largest in volume and boasts the largest island (Manitoulin) of any freshwater lake on Earth. The retention time for water in Lake Huron is 22 years, and the average depth is 59 metres (195 feet). This long retention time and large surface area have resulted in the build up of persistent substances that bioaccumulate in fish and wildlife.

The diverse shoreline of Lake Huron is the longest of the Great Lakes, its length extended by the shores of its numerous islands. Rocky shores associated with the Precambrian shield cover the northern and eastern shores, limestone dominates the shores of Manitoulin Island and the northern shore of the Bruce Peninsula, and glacial deposits of sand, gravel, and till predominate in the western, southern, and south-eastern portions of the shore. Shoreline and inshore habitats are correspondingly diverse.

Along the Canadian shore of Lake Huron, loss of wetland habitat on a large scale has not occurred because most of the shoreline is sparsely populated. Losses tend to be concentrated around the small urban centers that dot the shore. Within the last 10 years, there has been incremental and site-specific loss of wetland area from agricultural encroachment and cottage development. Over 40 species of rare plants, 5 rare reptile species, and 59 fish species use the coastal wetlands of Lake Huron.

2.2 The Partnership

In 2002, the federal, state and provincial agencies that manage binational environmental activities under the Great Lakes Water Quality Agreement formally endorsed the formation of a Lake Huron Binational Partnership in order to prioritize and coordinate environmental activities in the Lake Huron basin. The United States Environmental Protection Agency (USEPA), Environment Canada (EC), Michigan's Departments of Environmental Quality (MDEQ) and Natural Resources (MDNR) and Ontario's Ministries of Environment (MOE) and Natural Resources (MNR) form the core of the Partnership, by providing leadership and coordination. However the Partnership emphasizes the importance of maintaining a flexible membership which is inclusive of other agencies and levels of government, Tribes/First Nations, non-government organizations and the public on an issue-by-issue basis.

This partnership builds upon the efforts begun by the Michigan Department of Environmental Quality's Office of the Great Lakes in their Lake Huron Initiative. Through the Lake Huron Initiative priority actions were identified for the Lake Huron Basin regarding use impairments, critical pollutants, habitat, and biodiversity. The Lake Huron Initiative developed an Action Plan for Lake Huron in 2000 and updated in 2002 which outlined priority programs and initiatives. Many of these activities are now being addressed through the Lake Huron Binational Partnership.

The Partnership facilitates information sharing and priority setting for binational environmental protection and restoration activities of importance in the Lake Huron basin and also promotes cooperation and collaboration towards shared objectives that can not be accomplished by individual agencies alone.

Public consultation is an important component of the Partnership's activities in the Lake Huron basin particularly on a project specific level. Those individuals and organizations which have a direct interest in an issue will be targeted to participate or provide input to project direction and implementation. The agencies in the Partnership will work with existing mechanisms and groups as much as possible to consult and provide information to the public. The Lake Huron mailing list, through which general information will

be provided, includes municipal governments, environmental organizations, special interest groups and members of the public. A series of stand-alone fact sheets has been produced on the following topics: The Binational Partnership; Contaminants in Fish; Contaminants in Wildlife; Developing Environmental Objectives for Fish Communities; Lake Huron GIS; and Changes in the Lake Huron Fish Community.

The Partnership is an action-oriented process for identifying priority issues and efforts needed to ensure a healthy Lake Huron watershed. The binational work plan includes U.S., Canadian, and joint actions focused on short term project implementation and longer-term priority setting.

2.3 The Issues

The participants of the Partnership have agreed upon three initial binational issues to focus on:

- **contaminants in fish and wildlife,**
- **biodiversity and ecosystem change, and**
- **fish and wildlife habitat.**

These key issues were given priority for immediate action while other issues will be tracked and added as the Partnership pursues an iterative process of updating and expanding activities over time.

The subject areas that are being addressed through the efforts of the Partnership include:

- Status and trends of contaminants in fish and wildlife, chemicals causing fish consumption restrictions. The identification of potential sources and implementation of reduction measures.
- Scope and causes of observed changes in ecosystem structure and function. The impact of invasive species on food web dynamics, fish communities and biodiversity.
- Status and trends of fish and wildlife populations and habitat. The evaluation, protection and restoration of critical habitat such as wetlands, fish spawning areas and nesting sites for waterbirds.

While these topics are being addressed binationally, other issues are managed domestically. These include the restoration of beneficial uses in the Areas of Concern, and other local issues such as fouling of beaches by algae and bacteria. The Partnership facilitates the sharing of information between countries on these domestic issues.

In order to streamline activities and minimize costs, the Partnership will work closely with existing programs. One example of this effort is the close tie to the Great Lakes Fishery Commission's Lake Huron Technical Committee and activities such as the development of Environmental Objectives. The basin's size and multiple bi-national political jurisdictions, require coordination among programs as well as special basinwide and local initiatives. While governmental agencies are in a position to provide leadership, success will depend on leveraging both governmental and non-governmental organization involvement and resources. Success will also require engaging local governments whose authority and local decision-making collectively has a significant impact on the natural resources and sustainability of communities throughout the Lake Huron Basin.

Fish and Wildlife Contaminants

Section 3: Fish and Wildlife Contaminants

3.1 Contaminants in Fish

The Michigan Department of Environmental Quality and the Ontario Ministry of the Environment collect and analyze many species of fish to determine whether chemicals are present in quantities that may be of concern to those eating sport-caught fish. Contaminants such as mercury, toxaphene, dioxins, and polychlorinated biphenyls (PCBs) can accumulate in fish, wildlife and humans and could be harmful to a developing fetus, young child or breast-feeding baby.

The sport fish contaminant monitoring program is the largest testing and advisory program of its kind in North America. Both Michigan and Ontario have major fish contaminant analysis programs in place which include coverage of the Lake Huron watershed. These programs annually evaluate the available fish contaminant information and place advisories on the consumption of specific species of fish depending on the levels of contaminants found.

3.1.1 Contaminant Trends

From the late 1970's to the early 1990's, concentrations of persistent, bioaccumulative substance such as PCB, DDT, dieldrin, dioxins, and furans declined significantly in Lake Huron lake trout. However, while concentrations of DDT continued to decline up until 1995, PCB concentrations have not declined significantly since the mid 1980s (Figure 3.1). As with other trends, concentrations decreased significantly in the late 1970s but have remained relatively stable since.

Lake Huron Contaminant Trends in Top Predator Fish

Contaminant	Long-term Trends	Recent Trends
PCBs	Declining	Leveling off
Dioxins	General decline	
Mercury	General decline	Leveling off
DDT	Declining	

Source: Environment Canada/U.S. Environmental Protection Agency, 1997

Figure 3.1

Continuing sources of contaminants are primarily from sediments contaminated by historic discharges, airborne deposition, industrial and municipal discharges and land runoff. Contaminants enter Lake Huron through a variety of pathways including direct discharges, atmospheric deposition, and tributary discharge. Pesticides such as DDT, Toxaphene, Mirex, Chlordane and Aldrin/Dieldrin have been banned from use in the U.S. and Canada; however, they are still cycling within the environment through run-off, sediment resuspension and long range atmospheric transport. The large surface area of Lake Huron, like the other Great Lakes, has made it particularly vulnerable to atmospheric deposition of contaminants. Lake Huron has a large surface area and relatively few local contaminant point sources. Pollutant loadings to Lake Huron from water sources are lowest of all the Great Lakes but air sources are highest. The persistence of contaminants in the aquatic environment varies from substance to substance.

The breakdown or transformation of contaminants into forms that are inactive or less toxic may take anywhere from minutes to years. As a result, for the more persistent substances such as PCBs and DDT,

it may take many years of collecting and assessing data for trends to become clear. The data collected through the sport fish contaminant monitoring programs are particularly effective in detecting increases or decreases in contaminant levels over time.

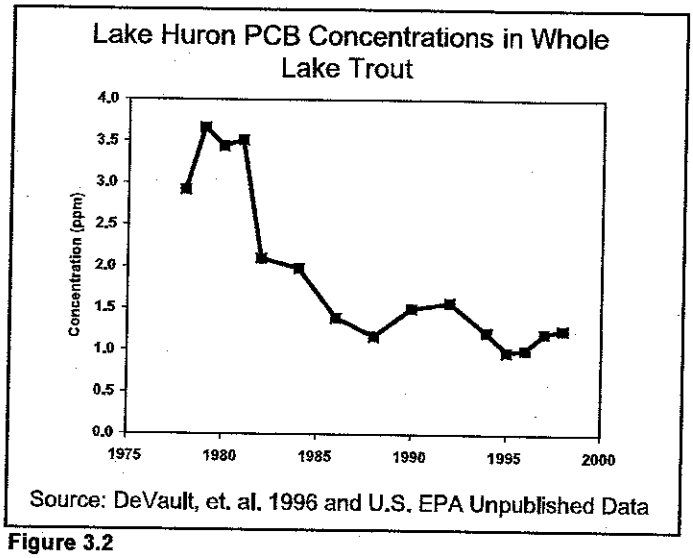


Figure 3.2

Contaminant concentrations in fish from the open waters of Lake Huron have been monitored because of human and wildlife health concerns. Because certain contaminants bioaccumulate and biomagnify in the food chain, fish are excellent indicators of pollutants in the aquatic ecosystem. Over the long term, trends of PCBs in fish have tended to closely follow those in the water column and have provided a measure of the relative rates at which chemicals have entered the Lake Huron ecosystem. During the period 1977-1990, PCB concentrations declined significantly in lake trout in Lake Huron (Figure 3.2). However, these declines have not continued in recent years. Compared to the rate at which PCBs declined in lake trout over earlier time periods, concentrations have not declined significantly in lake trout from Lake Huron since the mid 1980s. While PCB concentrations in open lake fish have declined dramatically in response to regulatory activity, concentrations in top predator fish species are still above the Great Lakes Water Quality Agreement objective of 0.1 ug/g (in whole fish).

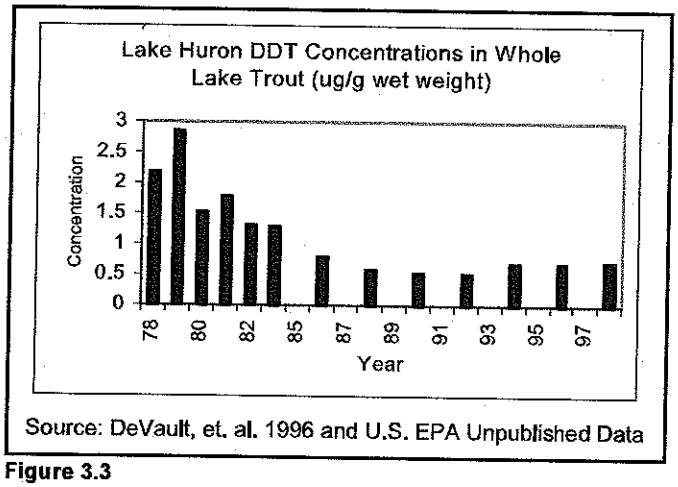


Figure 3.3

Total DDT declined significantly over the period of record in fish from Lake Huron (Figure 3.3). DDT concentrations have increased slightly in Lake Huron since 1995. Average DDT concentrations are below the International Joint Commission's Great Lakes Water Quality Agreement objective of 1.0 ug/g in whole fish.

In most areas of Ontario, contaminant levels have been declining due to bans on harmful substances and restrictions on emissions. Ontario sportfish contaminants analyses are based on the dorsal fillet section of the fish, not the whole fish as in Michigan. In the Ontario waters of Lake Huron, PCB levels in sport fish have been steadily declining to below the consumption restriction guideline (500 ppb). However, from 1990 to 2002, levels have remained stable. In Figure 3.4, the lake-wide average PCB levels for five year intervals in a typical (55cm) lake trout are shown. Figure 3.5 shows the lake-wide average dioxin/furan toxic equivalents in lake trout. Dioxin and furan levels exceeded the consumption guideline for 55 cm lake trout in 1990. Since that time levels have also declined considerably.

In Figure 3.6, the mean lake-wide mercury levels are compared in multiple year categories. The mercury concentrations in walleye have declined and remain below the consumption restriction guideline (0.45 ppm). However, mercury levels have been relatively stable over the past 20 years. Toxaphene, a banned persistent insecticide, exceeded the consumption restriction guideline (201 ppb) between 1987 and 1995 for 55 cm lake trout. Since that time, toxaphene levels have declined to below consumption guidelines.

In Georgian Bay, PCB levels are generally lower than in Lake Huron. Figure 3.7 shows PCB concentrations in 55 cm lake trout. None of the levels exceeded the guideline for fish consumption (500 ppb). Toxaphene concentrations in 55 cm lake trout from Georgian Bay exceeded the consumption guideline (201 ppb)

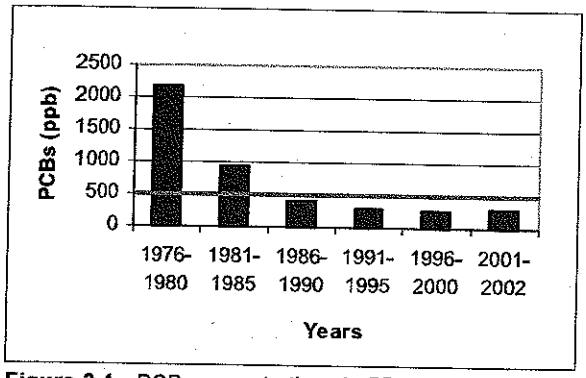


Figure 3.4 PCB concentrations in 55 cm lake trout from Lake Huron (Source: OMOE, 2004).

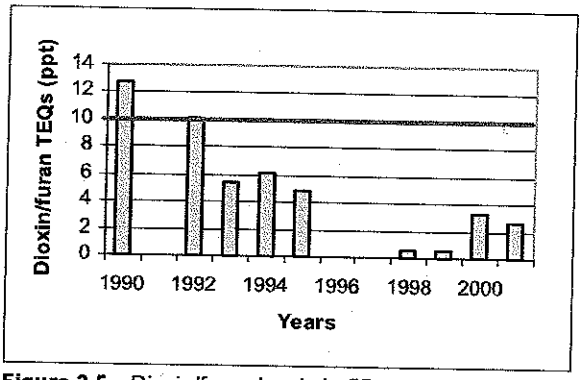


Figure 3.5 Dioxin/furan levels in 55 cm lake trout from Lake Huron (Source: OMOE, 2004).

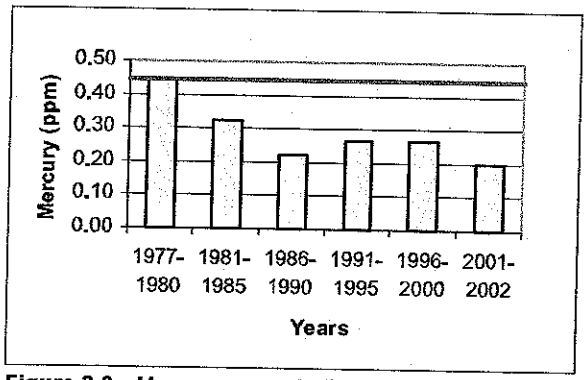


Figure 3.6 Mercury concentrations in 45 cm walleye from Lake Huron (Source: OMOE, 2004).

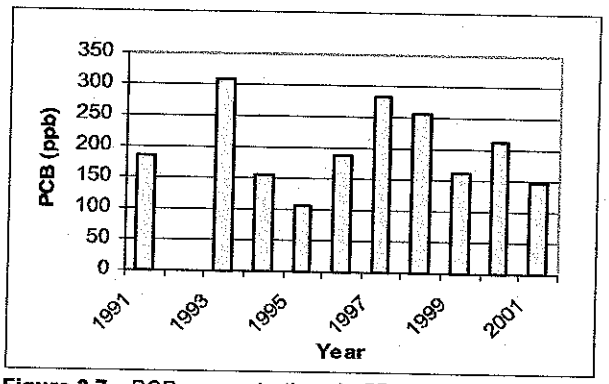


Figure 3.7 PCB concentrations in 55 cm lake trout from Georgian Bay (Source: OMOE, 2004).

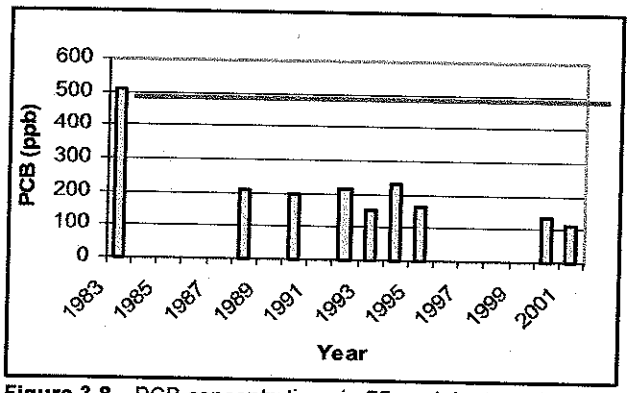


Figure 3.8 PCB concentrations in 55 cm lake trout from the North Channel (Source: OMOE, 2004).

between 1996 and 1997. Since that time, toxaphene levels have decreased to below the consumption restriction guidelines in Georgian Bay. In the 2003-04 guide, dioxins and furans were the cause of only one consumption restriction (65-75 cm lake trout). Overall, the percentage of consumption restrictions for fish from Georgian Bay (15.5%) was much less than those for Lake Huron (26%).

In the North Channel, the percentage of fish consumption restrictions (16.5%) is also much lower than in Lake Huron. The PCB levels in lake trout in the North Channel have declined since 1983 (Figure 3.8). Recent levels are well below the consumption restriction guideline (500 ppb). Toxaphene levels in 55cm lake trout exceeded the consumption guideline in 1987 and 1989 but have decreased considerably since that time.

3.1.2 Fish Consumption Advisories

Fish consumption advisories are based on guidelines developed through research and review of toxicological data. Both Michigan and Ontario have determined a safe dose for an extensive list of contaminants. This amount is referred to as a tolerable daily intake. It is then determined what proportion of the tolerable daily intake comes from each of the environmental pathways (e.g. air, water, different types of food), including sport fish consumption. A series of estimates and calculations are then done to determine if fish are

suitable for consumption. Fish Consumption Advisories are meant to inform consumers of the potential concerns.

In comparison to the other Great Lakes, contaminant concentrations are relatively low in Lake Huron. Nevertheless, fish consumption advisories exist for the open lake and all Areas of Concern (St. Marys River, Saginaw Bay and the Spanish River). Advisories differ by species, size and location, so it is important to check advisories in effect for the appropriate area.

In the Ontario waters of Lake Huron (including Georgian Bay, North Channel and St. Marys River) generally, the restrictions on trout, salmon, carp and channel catfish are caused by PCBs (Figure 3.9). The restrictions on other species are usually caused by mercury. In total, over 20 percent of the advice given for sport fish from Lake Huron results in some level of consumption restriction.

In the Michigan waters of Lake Huron (including Saginaw Bay and the St. Marys River) generally, the restrictions on trout, salmon, carp, channel catfish, burbot, northern pike, walleye, white bass, white suckers,

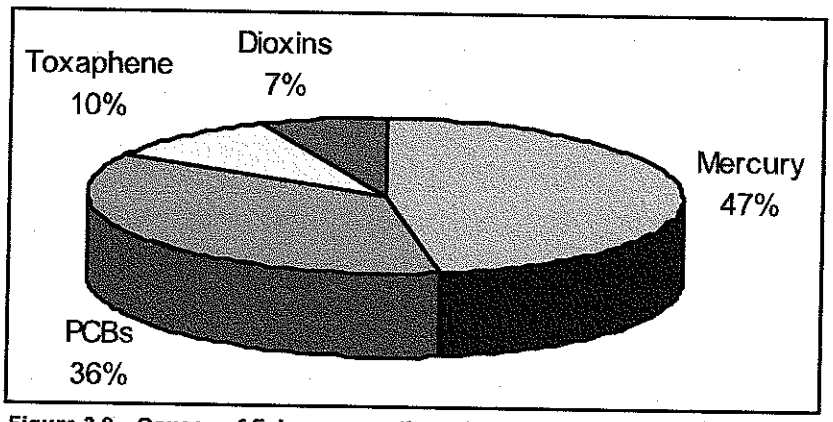


Figure 3.9 Causes of fish consumption advisories for the Lake Huron Watershed (2003-04 Guide to Eating Ontario Sport Fish (MOE)).

white perch and yellow perch are caused by PCBs. The other restrictions are caused by chlordane, dioxins, or mercury.

Based on the most recent information the current status of sport fish consumption advisories for both Ontario and Michigan are as shown below:

PCBs – In Michigan waters, almost every sample collected from Lake Huron exceeded the trigger level used by the Michigan Department of Community Health to issue sport fish consumption advisories for the protection of women of child bearing age and children under 15 years of age. Sport fish consumption advisories cover 15 species of Lake Huron fish. In addition, fish from several Lake Huron tributaries are covered by sport fish consumption advisories due to elevated concentrations of PCBs.

Toxaphene - Several species of Lake Huron fish including lake trout, lake whitefish and brown trout had toxaphene concentrations above the Ontario Ministry of Environment's sport fish consumption advisory trigger level.

Dioxins - Fewer dioxin analyses have been conducted on Lake Huron fish because of the relatively high cost of analyses. However, lake trout, lake whitefish and carp have dioxin concentrations above the trigger level used by both the Michigan Department of Community Health and the Ontario Ministry of Environment to issue sport fish consumption advisories. In addition, fish from the Saginaw River watershed are covered by advisories due to elevated concentrations of dioxin.

Chlordane - Concentrations of chlordane in Lake Huron lake trout occasionally exceed the sport fish consumption advisory trigger level (Figure 3.10).

Mercury - Only the methylated form of mercury bioaccumulates in fish tissue and a number of characteristics influence the methylation of mercury in the aquatic environment. Mercury methylation occurs more readily in inland lakes than in the Great Lakes. Therefore, sportfish consumption advisories due to elevated levels of mercury are more prevalent in fish from inland lakes within the Lake Huron watershed rather than fish from Lake Huron.

DDT/PBB - Concentrations of DDT and PBB rarely exceed sportfish consumption advisory trigger levels in Lake Huron fish. The only area of the Lake Huron watershed where concentrations are elevated is in the Pine River in the Saginaw River watershed.

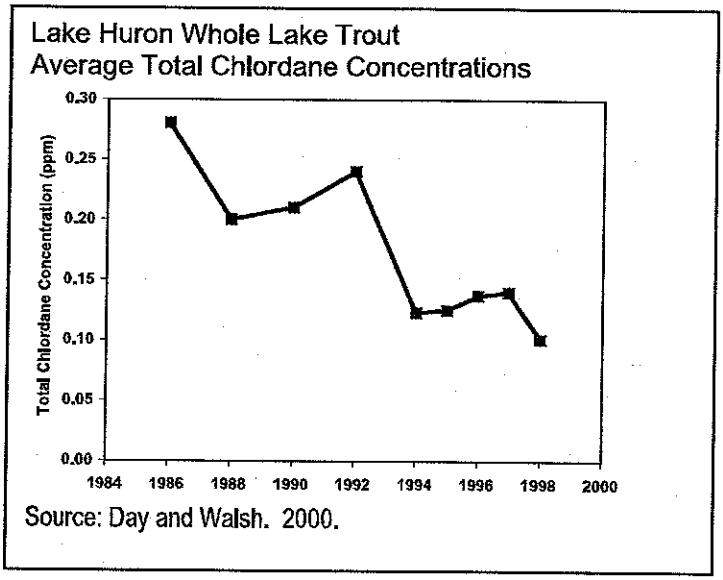


Figure 3.10

3.2 Contaminants in Wildlife

In the early 1970s, fish-eating birds (eagles, gulls, cormorants, etc.) on Lake Huron suffered widespread contaminant-induced reproductive failure, declining populations and eggshell thinning. With reductions in loadings of persistent toxic contaminants, such as PCBs, most fish-eating bird populations have recovered; numbers of herring gulls, Caspian terns, black-crowned night-herons and double-crested cormorants have increased significantly. However, some contaminant-associated problems, e.g. birth defects, impaired physiological responses and/ or reproductive failure, continue to occur in a small percentage of the populations in local areas.

It is important to monitor temporal and spatial trends in contaminants in these species and to identify potential problem areas and sources. Recently, to obtain more detailed geographical information, monitoring programs have included other aquatic-feeding species such as reptiles, amphibians, mink and otter. Contaminants such as PCBs, chlordane, dioxins and DDT have a strong association with reproduction and health in these species and this information, together with the fish-eating bird monitoring data, provides a more complete picture of the wildlife health effects of contaminants in the Lake Huron ecosystem.

3.2.1 Fish-Eating Birds

The Canadian Wildlife Service (CWS) of Environment Canada has been monitoring contaminant levels in herring gull eggs at 15 Great Lakes sites since 1974. The three Lake Huron sites are: Channel-Shelter Island, Double Island and Chantry Island (Figure 3.11).

The program tracks temporal and spatial trends in contaminant levels and effects in a top avian aquatic predator in the Great Lakes food web. Contaminants levels have declined dramatically at all three CWS Lake Huron sites since 1974, although the rates of decline for some compounds slowed during the 1990s (Figure 3.12). In spite of these declines, PCB and dioxin levels in gull eggs from Channel-Shelter Island continued to remain elevated compared to other Great Lakes sites. While major point sources

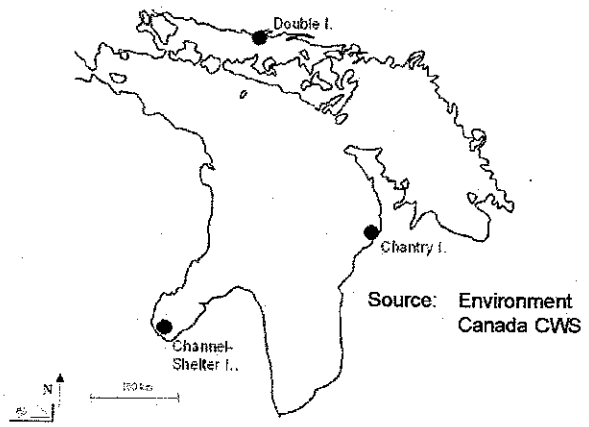


Figure 3.11 Canadian Wildlife Service Annual Herring Gull Monitoring Sites

of chemical contaminants are not found on the Canadian side of Lake Huron, atmospheric deposition, agricultural run-off, re-suspension of sediments and leaching of soils from landfill sites contribute to the steady state that has been evident since the 1990s. Year-to-year fluctuations in contaminant levels result from changes in food abundance associated with/or changes in weather conditions (Fox et al. 1990, Ewins et al. 1992).

The Michigan Department of Environmental Quality (MDEQ) began a similar annual gull egg monitoring project in 1999, augmenting the CWS work. Their sites include the outer Saginaw Bay, Alpena, St. Ignace and Sault Ste. Marie. MDEQ data are reviewed each year for new parameters for which wildlife should be analyzed.

High concentrations of brominated diphenyl ethers (BDEs) in Great Lakes herring gulls have recently been identified as a concern (Norstrom et al. 2003). Total BDE in herring gull eggs sampled from Double and Chantry Islands in 2000 were low (308-320 ug/kg) in comparison to other Great Lakes sites (1400 ug/kg in Green Bay), largely due to their remoteness from large urban/heavy industrial centres. Little is known with regard to the toxic effects of brominated diphenyl ethers in humans and wildlife.

In addition to Herring gull egg monitoring, the CWS occasionally measures contaminants in eggs from double-crested cormorants, ring-billed gulls, black-crowned night herons, great black-backed gulls and several species of terns. Generally, levels of contaminants in these species from Lake Huron sites were lower than other Great Lakes sites (Pekarik et al 1998; CWS unpublished).

In hunted waterfowl from Georgian Bay and Sault Ste. Marie, Braun et al. (1999) found that organochlorines, PCBs and mercury in pectoral muscle were low and did not pose a risk to wildlife. One exception was a common merganser from Sault Ste. Marie with the highest PCB concentrations of all waterfowl and gamebirds collected across Canada from 1987 to 1995. The reason for these high levels is unknown.

Bald eagles are a very sensitive top level predator and are often considered the ultimate contaminant indicator species. They have begun to return to the Great Lakes and can be used as indicators of contaminant trends by sampling contaminants in blood. Elevated levels of contaminants have been found in some eaglet blood samples from Georgian Bay (Donaldson et al. 1999) and Lake Huron watersheds (Saginaw River, Shiawassee Cutoff) although the 1999-2001 samples were significantly lower than in 1987-1992 (Roe et al. 2004)

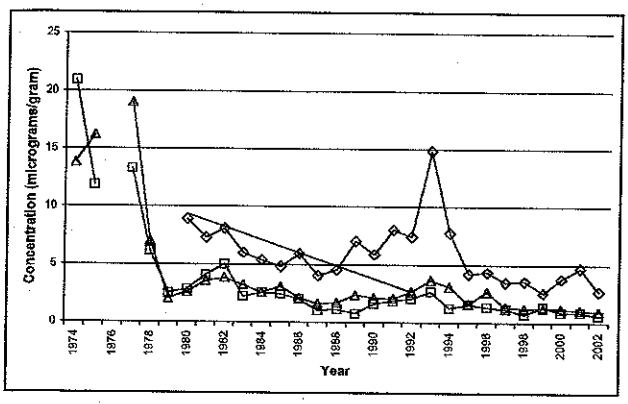
Exposure to heavy metals has been identified as a concern for bald eagles since several bald eagles found dead in the last few years in Ontario have had elevated levels of both mercury and lead in their bodies (Badzinski and Richards, 2002). Adult longevity and nest occupancy turn-over rates, including age of replacement birds, are other important factors which will ultimately determine how successful nesting bald eagles are on the shores of Lake Huron.

Ospreys are often used as local indicators in areas where there are few or no eagles. During 1991-1993 DDE concentrations in Osprey eggs and plasma were significantly higher in Georgian Bay than at inland sites in Ontario (Martin et al. 2003). Mean concentrations of DDE were lower than the critical value (4.2 ug/g) associated with significant eggshell thinning, however 20% of eggs from Georgian Bay were above this level. In terms of heavy metals, all samples taken from the St. Marys River and Georgian Bay (1991-1993) had mercury levels below those expected to cause adverse effects on reproduction. Thus, the Canadian Lake Huron osprey population does not appear to be affected by the current level of contaminants.

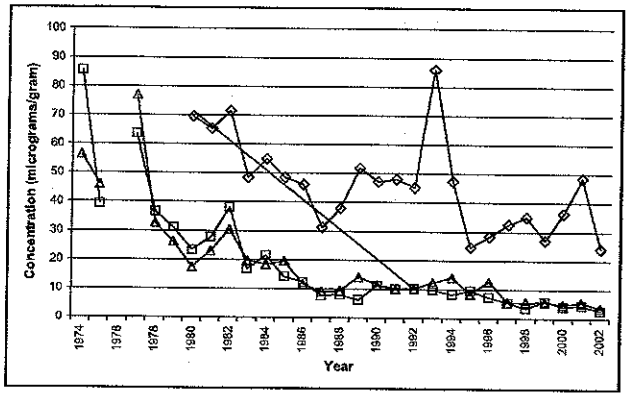
3.2.2 Other Wildlife

Snapping turtles are ideal monitors of wetland health due to their sedentary nature, their position as a top predator in the food chain and their ability to accumulate high levels of contaminants over the course of their long lives. Geographic variation in contaminant levels have been shown to be similar to the variation reported for herring gull eggs at other Great Lakes sites (Struger et al. 1985). Mink and otter both live in wetland habitat near the shoreline and consume various amounts of fish in their diet. Mink are one of the most sensitive mammals to PCBs, resulting in reproductive problems and death. Trends in mink populations have followed those of fish-eating birds; the population began to decline in the mid 1950s and was lowest

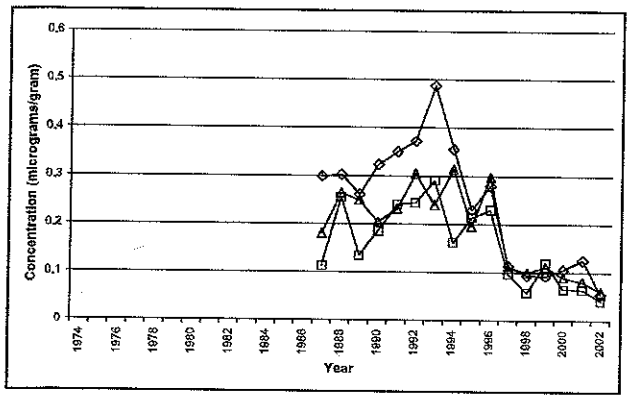
Figure 3.12 Temporal Trends in Levels of Contaminants in Herring Gull Eggs at Three Lake Huron Annual Monitor Colonies.



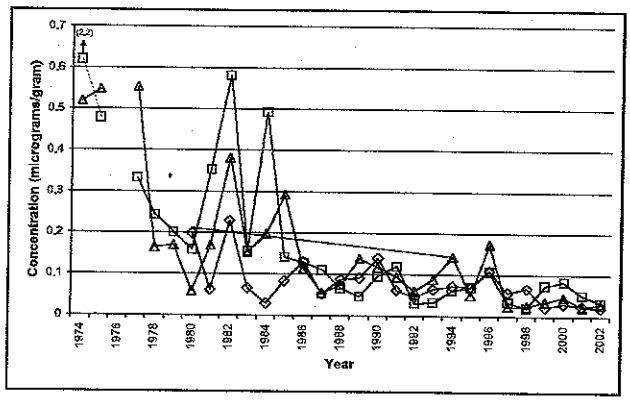
a) DDE



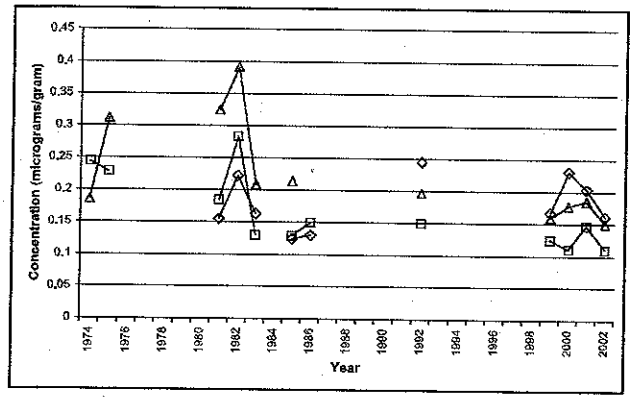
b) PCB 1254:1260



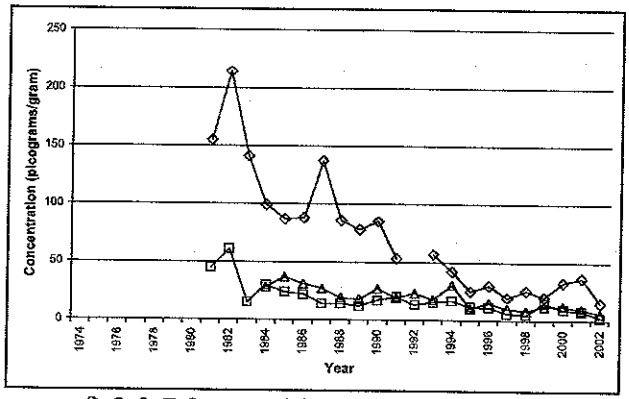
c) Total chlordane



d) Mirex



e) Mercury



f) 2,3,7,8-tetrachlorodibenzo-p-dioxin

LEGEND
- Chantry Island
- Double Island
- Channel Shelter Island

in the early 1970s but recovered somewhat in the 1980s. Otter have a lower rate of reproduction and therefore, are slower to recover.

Mink and otter are also sensitive indicators of mercury in the aquatic environment. Total mercury concentrations in otter tissues from near Parry Sound were higher than those in mink tissues, possibly due to their more piscivorous-based diet compared to mink (Klenavic, 2004). Mercury levels in otter hair were within the range found in studies in southern Ontario. Levels reported for Lake Huron otter were well below action thresholds.

In summary, wildlife information has indicated that PCBs, chlordane, dioxins and DDT are a concern in the Lake Huron basin although, with the exception of Saginaw Bay (PCBs, dioxin), concentrations are low compared to the other Great Lakes. Concentrations have declined significantly since the early 1970s but still remain at levels associated with deformities and reproductive effects in several local watersheds in Michigan, especially Saginaw Bay. Data collected in Ontario's wildlife species were generally not at levels of concern although sporadic elevated measurements support the need for continued ongoing monitoring.

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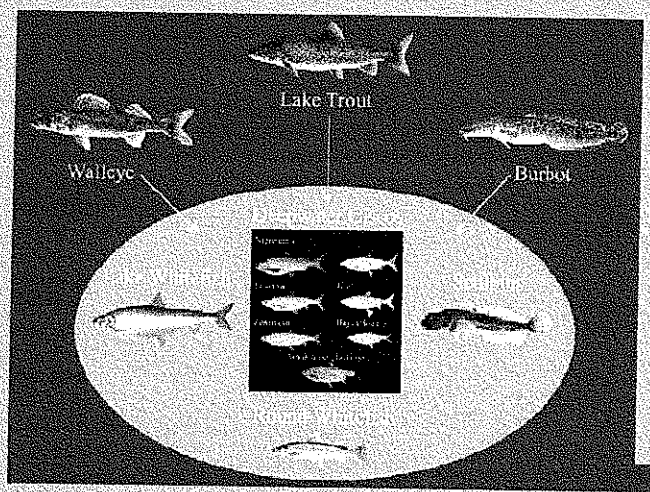


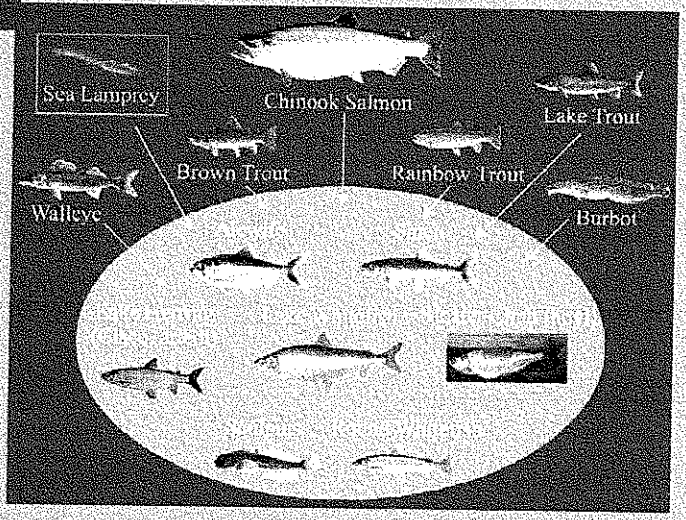
Historic Lake Huron Offshore Ecosystem

The original ecosystem had fewer predators and many more prey fish species.

Current Lake Huron Offshore Ecosystem

The current ecosystem has many more predators and Both predators and prey are dominated by introduced species.

Many of the original deepwater cisco species in Lake Huron are extinct.



Aquatic Ecosystem

Section 4: Aquatic Ecosystem

Since French explorer Étienne Brûlé first saw Lake Huron in 1612, the lake ecosystem has undergone many changes. Among the most significant change to the fish community have been the invasion of rainbow smelt (*Osmerus mordax*) in the 1920's, and alewife (*Alosa pseudoharengus*) and sea lamprey (*Petromyzon marinus*) in the 1930s. Sea lamprey predation and overfishing led to the collapse of lake trout (*Salvelinus namaycush*) by the 1950's (although two remnant stocks barely survived). With no predators to control alewife and smelt populations their numbers exploded and nuisance die-offs of alewife commonly littered beaches during the 1960s.

The turnaround came with sea lamprey control in the 1960s which allowed the survival of stocked Pacific salmon (*Oncorhynchus spp.*), lake trout and other predators. Restocking controlled both smelt and alewife populations, prevented nuisance alewife die-offs and resulted in exceptionally good fishing.

4.1 Lake Huron Aquatic Foodweb

The original Lake Huron ecosystem had lake trout as the main predator together with burbot (*Lota lota*) in the deeper waters, and walleye (*Sander vitreus*) the main nearshore area predator. The historic prey base was dominated by lake herring (or cisco) (*Coregonus artedii*) and a number of other species of deepwater ciscos (*Coregonus spp.*), with sculpins (*Cottus spp.* and *Myoxocephalus quadricornis*), lake (*Coregonus clupeaformis*) and round whitefish (*Prosopium cylindraceum*) contributing to a lesser extent.

The historic Lake Huron off-shore ecosystem had fewer predators and many more prey fish species. The current ecosystem has many more predators and both predators and prey are dominated by introduced species. Many of the original deepwater cisco species in Lake Huron are extirpated. (Refer to the section divider for illustration of aquatic ecosystem.)

Today chinook salmon (*Oncorhynchus tshawytscha*) are the dominant consumer in the lake, feeding mainly on non-native forage (alewife are their main prey with smelt being second) and lake trout are still a significant factor due to continued stocking. The abundance of both alewife and smelt can fluctuate significantly between years which can influence growth rates and survival of predators.

Six sites of natural reproduction of lake trout have been documented on Lake Huron and one has been deemed rehabilitated. Despite this level of success much work is needed to rehabilitate lake trout to even a small portion of their former abundance across the lake.

On Lake Huron the impact of industrialization and human population density has not been as great as on some of the other Great Lakes. The lake is, however, vulnerable from future impacts due to it's being within easy commuting distance of much higher population areas and is a popular destination for millions of cottagers, tourists and anglers. The mounting development pressures on Lake Huron from improved highways, and diminishing resources in other locations, will likely increase harvest and development pressure and strain the achievement of resource sustainability. Continued vigilance is needed to insure that future development on Lake Huron is done in a sound ecologically sustainable manner while efforts to seek solutions to existing problems continue to occur.

4.2 Fishery Management Goals

Fish Community Objectives (FCO) for Lake Huron were developed in 1995, and were in most cases yield targets by species based on historic commercial fishery landings from 1912-1940. An emerging realization is that historic harvest, and even current levels for some species, may not be sustainable in the long-term. Historic commercial fishery practices such as switching to different targeted species, fishing different fish stocks, changes in fishing effort and fishing power may all have masked the steady decline of fish populations over this historic time period.

In addition, the current ecosystem may not be as productive as in the past since non-native prey species are not as efficient in utilizing the primary and secondary production of the lake as were historic species,

such as the diversity of ciscos that once inhabited the lake. The introduction of non-native species such as zebra (*Dreissena polymorpha*) and quagga mussels (*Dreissena bugensis*) and the spiny water flea (*Bythotrephes cederstroemi*) may also divert much of the primary and secondary production of the lake to different pathways, making it unavailable to top predators.

Non-native salmonids which feed almost exclusively on alewife and smelt, are likely less efficient at utilizing productivity than indigenous lake trout, in that lake trout has a much more varied diet and would historically have utilized some portion of the available benthic prey in addition to forage fish to support their population size.

Taken in context, historic yield can provide an idea of what a fully recovered fish community might sustain rather than a specific target. The Great Lakes Fishery Commission (GLFC) currently facilitates the publishing of State of the Lake Reports for each of the Great Lakes on a five year rotation. A critical review of the lake status relative to FCOs is currently being conducted and FCOs will be updated as required.

To better facilitate the cooperative management of fisheries resources a framework for inter-jurisdictional coordination of fisheries management based upon an ecosystem context was developed. This "ecosystem approach" to fisheries management recognizes that the resources of the Great Lakes must be managed as a whole, that healthy fish communities require functioning, diverse habitats and clean water. FCOs for Lake Huron were completed in 1995 and described what was considered a "desirable" fish community based upon accepted ecological concepts and guiding principles. In order to support these FCOs, Environmental Objectives (EOs) are being developed to describe the biological, chemical and physical needs of these desired fish communities. The rehabilitation of Saginaw Bay, which once accounted for a significant proportion of lake wide yield of fish species, and making stream habitats currently blocked by man-made barriers available to migrating fish, rank as key targets for future habitat work.

With multiple resource agency input, the development of draft EOs was initiated in 2002 and the current version is undergoing critical review. These draft EOs provide a summary of the major environmental impediments to achieving FCOs in Lake Huron. A summary of the draft Environmental Objectives is provided below:

4.2.1 Spawning and Nursery Habitats

Maintain, protect and restore the integrity and connectivity of wetland spawning, nursery and feeding areas throughout the Lake Huron basin. Coastal wetlands throughout Lake Huron provide critical spawning, nursery and feeding habitat for a variety of fish species. Northern pike (*Esox lucius*) and muskellunge (*Esox masquinongy*) spawn exclusively in wetland areas whereas other species such as yellow perch (*Perca flavescens*), walleye, and minnow species use these areas as nursery and feeding sites. Historical losses of Lake Huron wetlands through drainage, infilling and other physical alterations have been significant. Many remaining wetlands are degraded or no longer accessible due to shoreline armoring.

Protect and restore connectivity and functionality of tributary spawning and nursery areas throughout the Lake Huron Basin. The Lake Huron watershed is one of the largest in the Great Lakes with numerous rivers and streams draining into the basin. The principal spawning and nursery habitats for a variety of species including lake sturgeon (*Acipenser fluvescens*), walleye, pacific salmonids (*Oncorhynchus spp.*), and suckers (*Catostomus spp.*) are found in these tributaries. Unfortunately, rivers and streams are some of the most altered and disrupted habitats in the Lake Huron basin. Many of the watersheds draining into Lake Huron have barriers to upstream access and have flow regimes that have been altered as a result of watershed land-use changes or hydro-electric generation needs.

Protect and restore reef spawning areas throughout the Lake Huron Basin. Lake Huron is a deep oligotrophic lake with a fish community that was historically dominated by deep dwelling species such as lake trout, whitefish and ciscoes. Most of these species utilize offshore or nearshore reefs for spawning purposes. Nearshore and offshore reefs are one of the most common habitat features throughout the Lake Huron basin. For the most part these habitats have not been physically altered to the same extent as

other habitat types, however, the colonization of these habitats by invasive species such as zebra mussels and round goby (*Neogoblus melanostomus*) has accelerated in recent years and may in time degrade the quality of these habitats.

4.2.2 Shoreline Processes

Protect and rehabilitate nearshore habitats and reestablish the beneficial structuring forces of natural water exchanges, circulation, and flow that they provide. The alteration of nearshore areas due to human activities has been widespread throughout the Lake Huron basin but has been most pronounced in the populated areas in the southern part of the basin. Shoreline straightening, infilling, dredging, and other such activities alter nearshore currents, increase erosion and deposition of fine sediments and leads to the loss of habitat diversity. Since a majority of fish species inhabiting the basin use nearshore areas at some point in their life-cycle altering these areas results in the loss of fish production and change in fish community structure.

4.2.3 Food Web Structure and Invasive Species

Protect and where possible enhance or restore fish community structure and function by promoting native species abundance and diversity and avoiding further invasive species introductions. In particular, protect and restore keystone predators to control exotic species and cultivate a food web favorable to reproduction of native species. Fish communities throughout the Lake Huron basin have undergone substantive change over the last century. Historically, the offshore fish communities were characteristic of a large, deep oligotrophic lake with lake trout and burbot being the dominant predators and a variety of cisco species being the dominant prey species. In the nearshore waters, a relatively greater diversity of predators (walleye, northern pike, muskellunge, bass (*Micropterus spp.*)) were present as well as benthivores (sturgeon, suckers, channel catfish (*Ictalurus punctatus*)) and forage fish (herring, yellow perch, cyprinids). A variety of factors have been implicated in the loss or extinction of species in the basin and prominent among them is the proliferation of invasive species such as lamprey, alewife, rainbow smelt, and zebra mussels.

4.2.4 Water Quality

Protect and restore water quality throughout the Lake Huron basin, especially in the Areas of Concern and reduce or remove contaminant burdens from the fish community in order to avoid reductions in fish production and native species biodiversity, and to maintain fishable, swimmable, aesthetically unaltered waters for the enjoyment of future generations. Water quality throughout the Lake Huron basin has shown gradual improvement since the early 1970's. Some localized nutrient enrichment problems exist in Saginaw Bay and southeastern main basin and in northeastern Manitoulin Island. Acid rain and heavy metal contamination is still a localized issue in some parts of the North Channel and Georgian Bay. Consumption advisories due to contaminant levels are in place throughout the basin for a variety of fish species.

4.3 Invasive Species

Lake Huron has been dramatically and forever changed by the invasion of non-native species, which have decimated native fish populations and in some cases permanently impacted fish communities. Invasive species are defined as species that do not originate in the Lake Huron ecosystem and have been introduced either intentionally or accidentally. Invasive species threaten the diversity and abundance of native species and the ecological stability of infested waters.

The introduction of invasive species into Lake Huron has altered or disrupted existing relationships and ecological processes. This disruption can cause significant changes to the Lake Huron ecosystem such as alterations of food webs, nutrient dynamics, reproduction, sustainability, and biodiversity. Invasive species have few natural enemies such as pathogens, parasites and predators. Without co-evolved parasites and predators, they out-compete and even displace native populations. Not only do invasive species

compete with native species for food and habitat, they may also increase cycling of persistent bioaccumulative chemicals in the food chain. For example, research has shown that zebra mussels and round gobies are contributing to the cycling and bioaccumulation of PCBs (Jude 1996).

The recent invasion of zebra and quagga mussels, round gobies, the spiny water flea, white perch (*Morone Americana*) and ruffe (*Gymnocephalus cemuus*) into Lake Huron heightens the uncertainty for expectations from the ecosystem. Recently *Diporeia hoyi* (scud), a native invertebrate has declined significantly in abundance, especially in southern Lake Huron. There is a suspicion that the Diporeia decline may be related to the invasion of zebra mussels. Diporeia is a key diet item of lake whitefish and other desirable sport and commercial fish species.

The following is a description of a number of invasive species having a significant impact on the Lake Huron aquatic ecosystem.

4.3.1 Sea Lamprey

The sea lamprey has been a serious problem in the Great Lakes for more than 50 years. An adult lamprey can kill up to 40 pounds of fish in just 12 to 20 months. The St. Marys River, which flows between Lakes Superior and Huron has become the most important spawning area for lampreys in the Great Lakes.

Successful rehabilitation of Lake Huron lake trout populations has been hindered because of the high number of sea lamprey. Without question the sea lamprey problem in northern Lake Huron, associated with increased lamprey production from the St. Marys River, is the most severe impediment to a healthy fish community in the lake. By the1990's the St. Marys River was producing more sea lampreys than all other Great Lakes spawning tributaries combined.

Cost-effective sea lamprey control on the St. Marys, once thought to be impossible, may now be within reach because of a special program developed by biologists and research scientists working under the direction of the Great Lakes Fishery Commission. During 1998 – 1999, more than 840 hectares of the St. Marys River were treated with Bayluscide 3.2 percent Granular Sea Lamprey Larvicide. Additional treatments of sea lamprey "hot-spots" in the river have been conducted in more recent years. These treatments reduced the number of larval sea lampreys in the river by nearly 45 percent. Enhanced trapping and release of sterile male lampreys in the river reduced the reproduction potential by an estimated 92 percent. Although the Great Lakes Fishery Commission's fish community objective for sea lamprey (75 percent reduction) was not met for year 2000, the objective for 2010 (90 percent reduction) is attainable. However, funding for sea lamprey control remains at approximately 65 percent of that needed to fully fund the program.

4.3.2 Round Goby

The round goby are a small fish that feed chiefly on bivalves, amphipod, crustaceans, and small fish and fish eggs (Jude 1996). Consumption studies of fish suggest round gobies might have a detrimental impact on native species through competition for food and predation on eggs and young fish. To help control the expansion of the goby into other waterways, river barrier systems are being implemented along with aggressive public education programs. Unfortunately, no effective measures have been found to decrease established populations of goby.

4.3.3 Ruffe

The ruffe was first identified in Lake Huron in 1995 in Thunder Bay near Alpena, Michigan. The Ruffe adapts well to various environments, matures quickly, and spawns over an extended period of time. With a high level of adaptability, ruffe populations are on the rise, yet they have not spread from the Thunder Bay region of Lake Huron.

4.3.4 Spiny Water Flea

The spiny water flea was first discovered in Lake Huron in 1984 and is believed to have entered the waters of the Great Lakes through discharged ballast water (Mills et al 1993). Although its average length is rarely more than 1.5 centimeters, this predacious zooplankter can have a profound effect on a lake's plankton community. The spiny water flea has colonized all offshore areas of the lake.

4.3.5 Zebra and Quagga Mussels

Zebra mussels reproduce rapidly and are able to form dense layered colonies of over one million per square meter. Zebra mussels are a serious threat to Lake Huron ecosystem because they have tremendous filtering capacity for sediments and phytoplankton (Fanslow et al 1995). In many regions of the Great Lakes zebra mussels have had severe impacts on many native unionids and are of special concern to threatened and endangered species of bi-valves. Also, zebra mussels are a serious concern because they contribute to the cycling of contaminants by removing PCBs from the sediments and reintroducing them into the food web (Jude 1996). Quagga mussels are similar to zebra mussels in many respects but do prefer deeper water. They therefore have the potential to detrimentally impact aquatic species that use the deeper portions of the lake.

4.3.6 Other Aquatic Nuisance Species

Eurasian watermilfoil (*Myriophyllum spicatum*) is one of the most common species found in Saginaw Bay. Populations have thrived since the introduction of zebra mussels that have contributed to higher water clarity. Decreased light levels allow for fewer species to survive. Eurasian watermilfoil also reroutes nutrients from plankton to uprooted plants, depriving energy to the fish community. Purple loosestrife (*Lythrum salicaria*) is a perennial wetland plant that is impacting Lake Huron wetland ecosystems by changing the structure, function and productivity of the wetlands. The plant forms dense monoculture stands sometimes hundreds of acres in size. Purple loosestrife can displace native vegetation and threaten the biotic integrity of wetland ecosystems. *Cercopagis pengoi*, the fishhook water flea, is one of the most recent invasive species to Lake Huron. Cercopagis are a problem because they tangle lines in both recreational and commercial fisheries and have a large appetite for zooplankton (Ontario Federation of Hunters and Anglers 1999). Further ecological disruptions have not been completely determined and, therefore, Cercopagis are being closely watched.

In the future, additional non-native species will likely be introduced into the Great Lakes food web and will have unknown effects making it even more difficult, if not impossible, to define reasonable expectations for an ever changing ecosystem.

4.4 References

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Areas of Concern

Section 5: Areas of Concern in Lake Huron

In 1987, four AOCs were identified within the Lake Huron watershed, as well as the St. Marys River. Collingwood Harbour and Severn Sound in Canada were delisted in 1994 and 2003 respectively. Monitoring is ongoing in these areas to ensure that environmental quality is maintained. Each of the remaining AOCs are being addressed through on-going programs, as described below. For more information on AOCs, see the following websites:
http://gldev.on.ec.gc.ca/water/raps/map_e.html
http://www.epa.gov/glnpo/aoc/index.html

5.1 Spanish Harbour, Ontario

At the Spanish Harbour AOC, all recommended actions were completed and in 1999, the area was the first in the Great Lakes to be recognized as being an Area in Recovery. Heavy metal contamination in the river and harbour are being monitored for natural recovery. Results from a recent survey (October 2003) are being compiled and will be used to generate modeling predictions to estimate how long recovery may take. A six year muskellunge re-introduction program involving many partner organizations is now in the final assessment stages.

5.2 Saginaw River/Bay, Michigan

The Saginaw Bay Watershed is one of Michigan's most diverse areas-its rich resources support agriculture, manufacturing, tourism, outdoor recreations, and a vast variety of wildlife. The watershed is 8,709 square miles in size and is America's largest contiguous freshwater coastal wetland system. Contaminated sediments, fish consumption advisories, degraded fisheries and loss of significant recreational values are the major reasons for this AOC's designation. Saginaw Bay priorities include remediation of PCB contaminated sediment, nonpoint pollution control, wetland restoration, and habitat restoration.

The Stage 1 Saginaw River/Bay Remedial Action Plan (RAP) process began in July 1986 and was completed in September 1988. Following substantial progress, an updated Saginaw River/Bay RAP was developed in 1994. More recently, the Measures of Success report (2001) provides a foundation for redirecting and refocusing efforts. It recommends a list of targeted restored conditions that should be viewed as steps toward the delisting of the Saginaw Bay/River AOC. Preparation of the updated Saginaw River/Bay RAP is being done through the committee structure of the Partnership for the Saginaw Bay Watershed.

Major ongoing efforts are addressing contaminated sediments and floodplain soils within the Tittabawassee and Saginaw River. Sediments and floodplain soils in the Saginaw River Watershed contain a variety of organic compounds, including dioxins, furans, and PCBs. The 1998 $28.2 million natural resources damages settlement funded the removal of 342,433 cubic yards of contaminated sediments from the river, protection of coastal wetlands (1677 acres), and restoration of coastal wetland and lakeplain prairie on 391 acres. Portions of this settlement used as match for a $1M North American Wetlands Conservation Act (NAWCA) grant that is improving habitat on approximately 3,000 acres. Also, plans are being finalized for restoration of the hydrology of Tobico Marsh, a 900 acre wetland immediately adjacent and connected to Saginaw Bay. This project is expected to improve spawning opportunities for Saginaw Bay northern pike.

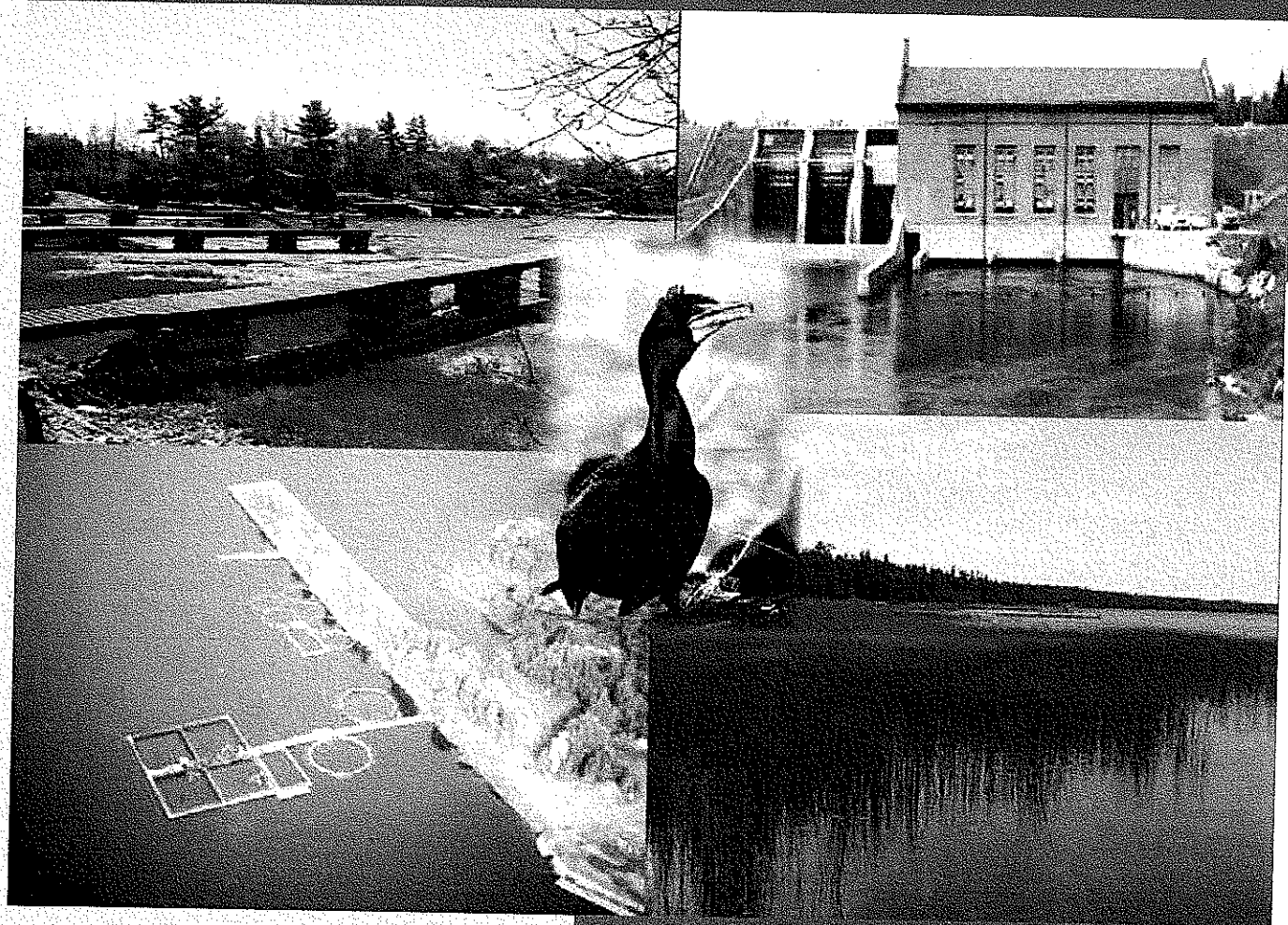
Existing data from US Army Corps of Engineers, U.S. EPA, and Michigan DEQ indicate that, at some locations, dioxin contamination exceeds human health risked-based regulatory levels and ecological risk based screening levels. Michigan Department of Environmental Quality is actively characterizing Saginaw River sediments and floodplain soils for compounds of regulatory and environmental significance. The data collected will assist in decision making regarding short-term protection of human health and the

environment and long-term remediation of the Saginaw River and Saginaw Bay. It will also provide input to similar decision-making on the Shiawassee River, a tributary of the Saginaw River. Michigan DEQ is engaging the community as an integral part of addressing the dioxin issues in the watershed and Area of Concern. A Community Advisory Panel (CAP) has been established to bring stakeholders together and advance remediation.

5.3 Binational Area of Concern: St. Marys River

The St. Marys River is a 112 km connecting channel between Lakes Superior and Huron and is subject to many activities under the binational Remedial Action Plan. Accomplishments on the Canadian side have included the development of wetland protection strategies, the recovery of walleye populations, the design of habitat features in the city's waterfront development, and installation of an activated sludge treatment facility to reduce the oxygen demand and suspended solids in the discharge water of the St. Marys Paper mechanical pulp mill. The Environmental Management Agreement with Algoma Steel, to be renewed in 2004, has likewise resulted in many improvements to both air and wastewater discharges. Current projects include: funding for the design of a strategy for contaminated sediment; review of delisting criteria; wastewater characterization study; and wetland conservation. Future challenges include the need to control inputs from the century-old Algoma slag site, long-term sea lamprey control efforts to restore impaired fisheries, and the finalization and implementation of a sediment management plan.

Priorities of the St. Marys River on the Michigan side are cleanup of the Cannelton Tannery Superfund site, sea lamprey control, and elimination of combined sewer overflows. The Cannelton Superfund site has been restored for re-use by the city of Sault Ste. Marie and its citizens. Once remediated, the site may support light industry, residential homes, or park areas. Certain use restrictions will apply to various parts of the site to prevent contamination from affecting human or ecosystem health. The sea lamprey control efforts will help restore impaired fisheries in the St. Marys River as well as northern Lake Huron and Lake Michigan. This will be a long-term, continuing effort since the opportunistic lamprey can take quick advantage of any lapse in larvae and adult control measures. Combined sewer separation in Sault Ste. Marie, Michigan has already eliminated the worst of the occasional overflows of sewage to the St. Marys River in Michigan waters. Continued work on this will eventually stop all potential for untreated sewage entering the river, even in the worst run-off events.



Other Lake Huron Issues

Section 6: Other Lake Huron Issues

There are a range of other issues in the Lake Huron basin which are being addressed by other programs or are beyond the current scope of the Partnership's priority issues. They are no less significant, however, so they are either being addressed domestically, through other programs or they are being tracked and over time, specific actions to address these issues may be incorporated into the Binational Partnership Action Plan.

6.1 Low Water Levels

Unlike the other Great Lakes, water levels in Lakes Huron (and Michigan since they share the same level) are approaching historic lows. Cyclic water level fluctuation is a natural occurrence, but recent low levels could be a regional response to global climate change. Many shoreline property owners have welcomed lower water levels since it has exposed increased amounts of beach and shoreline and reduced the potential for any property damage from erosion. Others are very concerned about exposed shorelines and the loss of existing wetlands which are being dried out as water levels drop. The low water levels that have recently occurred in Lakes Huron and Michigan are not being seen to the same extent in the other Great Lakes.

This situation created a novel regulatory issue. On the Michigan shoreline, receding water levels exposed shoreline mud flats and beaches that were colonized by emergent wetland vegetation. This represents restoration of a natural condition that has not existed for many years, and in many areas newly emerged wetlands represent a substantial increase in essential wetland habitat for fishes and waterfowl. However, some property owners, accustomed to sandy beaches and open lake, regard the new wetlands with disfavor and have attempted to secure beach grooming permits. Several cases of unpermitted vegetation removal have led to enforcement actions. The State of Michigan's Wetlands Protection and the Great Lakes Submerged Lands parts of Michigan's Natural Resources and Environmental Protection Act were recently amended to permit property owners to carry out limited vegetation removal, except in areas designated as Environmental Areas by the MDEQ, where threatened or endangered species may be impacted, or, in designated critical dune areas. The recent amendments to Michigan law designates Saginaw Bay as a pilot area that allows riparian property owners to remove certain types of vegetation from exposed bottomlands, after receiving a letter of approval from the MDEQ certifying that specified criteria are met. Vegetation removal in this pilot area is typically limited to 50 percent of a property owner's shoreline, or 100 feet, whichever is greater. A permit from the U.S. Army Corps of Engineers is required for mechanical removal of vegetation.

At the same time in some Canadian waters, particularly in Georgian Bay and the North Channel where different shoreline conditions exist, many wetlands have been significantly reduced in size through drying. This has reduced availability of critical spawning habitat for fish species such as northern pike, muskellunge and smallmouth bass. Currently, research is being conducted to assess impacts of these low water levels and compare the current situation to the historic state.

Botulism is a foodborne disease of vertebrates caused by the bacterium Clostridium botulinum. Infected organisms are affected by extremely potent neurotoxins produced by the bacteria. Botulism has been reported in fish-eating birds within the Great Lakes, and has caused periodic die-offs of fish-eating waterfowl and benthic fishes in Lakes Michigan, Huron, Erie and Ontario. The mechanism responsible for Great Lakes botulism outbreaks is not well understood. Monitoring is needed to determine if recent outbreaks represent an increase in frequency or a novel source of infection. Botulism outbreaks seem to be associated in some way with the spread of invasive zebra mussels and round gobies. The source and mode of toxin transfer are not fully understood, but research is underway.

6.2 Botulism

In recent years, outbreaks of Type E Botulism have left thousands of fish and waterbirds dead on Lake Huron (Ontario) area beaches. In 1998 and 1999, the outbreak appeared to be concentrated at the south end of the lake between Goderich and Sarnia. In 2002 and 2003, outbreaks occurred each year in the Goderich to Port Elgin area. The occurrences began in late summer and continued through the fall season until late November. There were also observations of decomposing algae collecting in embayments in the Kincardine area in the late summer. These events on Lake Huron are being studied along with similar events on Lakes Erie and Ontario to determine what conditions lead to these events.

6.3 Cormorants

Cormorants are fish-eating birds implicated in decreases in nearshore fish populations throughout the Great Lakes. Cormorant abundance was increasing in the middle of the 20th century but began a sharp decline in the 1960's due to reproductive failure induced by contaminants. Recent declines in pesticides such as DDT and an increase in available prey fish (primarily exotic species such as alewives) have allowed cormorant populations to increase. Breeding colonies are now established on many offshore islands. Many Stakeholder groups perceive cormorants as a direct threat to fisheries and have called for cormorant control. This is a complex issue because cormorant effects on local fisheries appear to vary greatly among breeding colonies. Cormorants clearly have an effect on island vegetation, and their excrement has denuded vegetation on some offshore islands. This has affected other bird species such as herons that nest on vegetated island sanctuaries.

Cormorant management is contentious because there has been disagreement on the absolute need for control measures, the level of control needed, and which control method should be used. Some stakeholders view shooting or trapping as inhumane. Inducing nest failure through egg-oiling is only slightly less controversial, but it requires several years of control before numbers are reduced. This is undesirable to stakeholders who want immediate action. Some control measures have been implemented, but a basinwide plan has not yet been developed. In Ontario waters of Lake Huron, the OMNR is currently conducting an extensive study to determine cormorant impacts on fish populations in Georgian Bay and the North Channel. Egg oiling is being conducted as part of this study but any wider-scale control efforts will proceed only if a significant negative effect of cormorants on fish populations can be demonstrated.

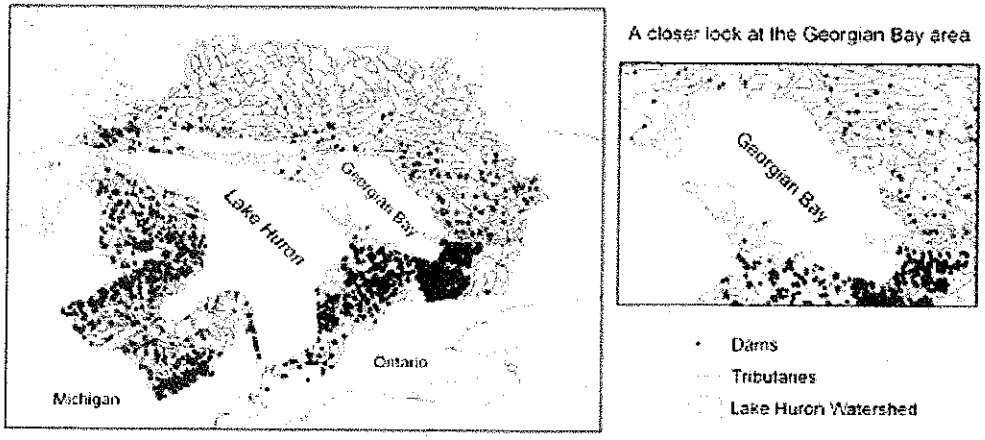
6.4 Coastal Wetlands

The Lake Huron nearshore coastal wetlands sustain an extensive diversity of wildlife that enriches the Lake Huron Basin. The physical structure and living communities of this area are as much a function of the lake's ecosystem as the fish in its depths. The action of waves and wind shape the beaches, dunes, and shore bluffs. These land forms and the local climate effects determine the biological communities. These communities, in turn, sustain the diversity of wildlife.

The shoreline of Lake Huron is the longest of the Great Lakes, its length extended by the shores of its numerous islands and bays. Rocky shores associated with the Precambrian shield cover the northern and eastern shores, limestone dominates the shores of Manitoulin Island and the northern shore of the Bruce Peninsula, and glacial deposits of sand, gravel, and till predominate in the western, southern, and

important sources of cool, high quality water, and they served as spawning and nursery habitats for many species. Fish were excluded from many of these areas in the 1800's through construction of mill dams and later through hydroelectric facilities. As shown in Figure 6.1 [below] dams now fragment many streams where historical spawning occurred for adfluvial fish (live in the open waters of the Great Lakes and use tributaries for spawning). For example, 106 dams occur in the watershed of the Au Sable River, Michigan, a high quality trout stream. Included are six large hydroelectric dams, which impound nearly all the highest gradient rapids on the lower river. These dams impound over 26 percent of the river's mainstream warm downstream reaches lessening their suitability for coldwater fishes and, prevent Great Lakes fishes from accessing 93 percent of the mainstream Au Sable River (Zorn and Sendek 2001). Many important fisheries and spawning rapids are no longer accessible.

Figure 6.1 Dams in the Lake Huron Watershed



6.8 Aquaculture

In Lake Huron, rainbow trout are stocked into floating pens at small size, fed prepared diets, and harvested when they reach marketable size. Currently these operations occur only in Ontario waters of Lake Huron and are mostly located in the North Channel. These operations support high fish concentrations that produce fecal material that can degrade water quality and alter benthic environments below pen rearing facilities. Proper siting of these facilities is critical, but aesthetic concerns can arise even in areas with suitable water circulation.

Additional concerns regarding these operations include introduction of unwanted organisms, diseases, or parasites. These can be introduced in shipments of eggs or young fish, and fish are known to escape rearing facilities. Rainbow trout were introduced into Lake Huron well over 100 years ago and have become naturalized, thus escaped pen reared fish would not represent a new introduction; however, interactions between pen reared escaped fish and naturalized rainbow trout are unknown. Despite these problems the industry provides a desired product with significant economic benefits and is working with various levels of government to develop technologies and best management practices to ensure ecological sustainability.

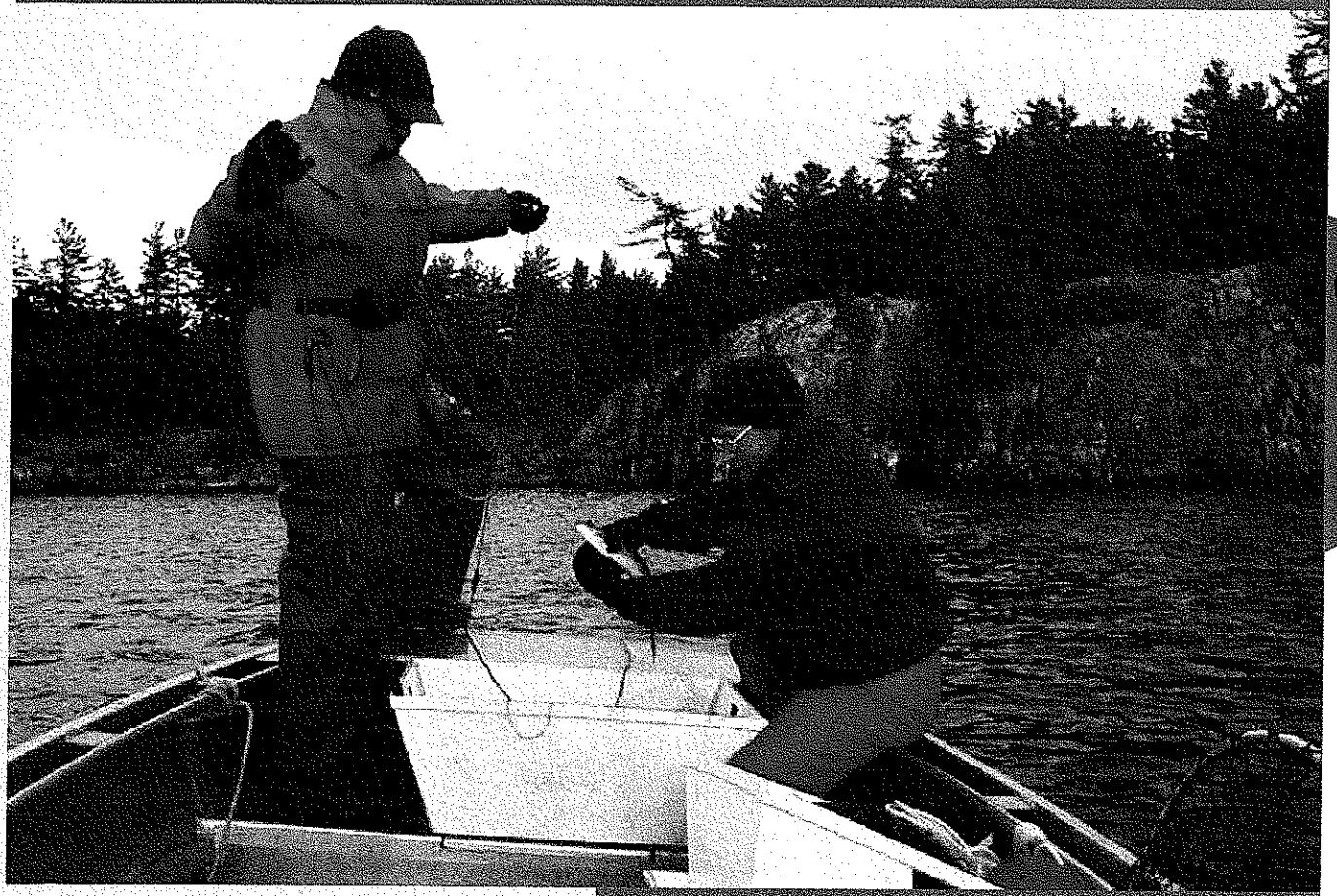
6.9 Global Climate Change

Global climate change may already be affecting Lake Huron by altering water levels. If current trends continue, further reductions in water level may be expected. This would exacerbate navigation and beach vegetation issues. A wide range of fisheries issues could occur if Lake Huron experienced additional warming: expansion of the near-shore fish community into deeper areas, increases in fish populations that are presently temperature limited (particularly alewife), and range expansion of both native and introduced fishes that are presently restricted to Lake Erie are possible. Global climate change may also

cause greater demand for fresh water, and any reduction or loss of fresh water in other regions of North America would heighten water demand and place greater pressure on Great Lakes residents to allow water withdrawal. While this might benefit the region economically, it opens the door to ecological, economic, and social issues that have not been considered.

6.10 Low-Level Contaminants

Recent advances in chemical detection techniques have revealed the presence of low concentrations of chemical contaminants that were previously not known to be present. Studies in other aquatic systems have detected a wide range of chemicals including personal care products (soaps and perfumes), human and veterinary drugs (antibiotics), natural and synthetic hormones, plasticizers, insecticides, fire retardants, and caffeine from coffee drinkers. Concentrations of these chemicals almost never exceed standards set for drinking water, but there are no standards for many substances because it was not known that they were even present. The primary concern with low-level contaminants is that they may serve as endocrine disrupters that affect growth, maturation, and reproduction of aquatic organisms. The problem is so new that many basic questions are as yet unanswered.



Action Plan

Section 7: Action Plan

Since the Lake Huron Binational Partnership was formed in 2002, partner agencies have been aligning their programs and projects to address the priority issues that have been identified through this effort. A workplan for both short term and long term activities has been drafted and many of these critical activities are already underway.

7.1 Canadian Watershed

In order to address binational priorities as well as issues on the Canadian side of the Lake Huron basin, a federal/provincial working group was established in 2002. A number of needs are met by the working group such as information sharing, partnering on projects as well as workplanning and reporting under the requirements of the Canada Ontario Agreement (COA). A south east shore working group functions as a subcommittee to the federal/provincial group and focuses specifically on the bacteria and algae fouling issues at Lake Huron's beaches along the shore from Southampton to Sarnia.

7.1.1 Activities Addressing Contaminants in Fish and Wildlife

Canadian information on contaminants in fish and resulting sport fish consumption advisories have been assembled, synthesized and combined with U.S. information into a fact sheet for general distribution by the Lake Huron Binational Partnership. In addition, a report summarizing current status, trends and distributions of wildlife along the Canadian shores of Lake Huron has been prepared and covers populations, contaminant levels and habitat of colonial waterbirds, marsh birds, waterfowl, birds of prey, amphibians, reptiles and mammals which feed on aquatic life in Lake Huron and its tributaries. The contaminant information from this report was combined with available U.S. data and presented in a Lake Huron Binational Partnership fact sheet.

By evaluating the status and trends of fish and wildlife contaminant levels, both geographically and temporally, it is possible to identify contaminants of concern to Lake Huron and recommend further investigations into suspected source areas and follow up with remedial measures.

7.1.2 Activities to Increase Understanding of Ecosystem Change, Biodiversity and the Impact of Exotic Species

The following projects are geared towards developing a better understanding of changes in Lake Huron:

- Integrated assessment of the microbial food web
- Lake Whitefish Food Web Interactions
- Trends in the Benthic Macroinvertebrate Community
- Growth, Condition and Energy Density of Lake Whitefish

In Canada, the federal Department of Fisheries and Oceans and the provincial Ministry of Natural Resources are engaged in a number of activities to study the structure and function of Lake Huron's ecosystem. Since the arrival of zebra mussels in the late 1980's and the subsequent and ongoing accidental introductions of a range of species from invertebrates to fish, shifts are beginning to take place in how food is transferred within the system and how aquatic communities are responding. Lakes Erie and Ontario have been subject to even more dramatic changes because of their smaller size and shallower depths. The microbial food web is an important link at the bottom end of the food chain, particularly in the offshore areas where nutrients are low. A study of the offshore communities and a comparison with nearshore areas has been underway since 2003 under DFO's lead with Canadian and U.S. researchers.

Benthic macroinvertebrate community trends were measured in 2000 and 2003 with an emphasis on changes in abundance of the amphipod Diporeia and dreissenid mussels (zebra and quagga) by NOAA

with MNR and Environment Canada's NWRI participation. A study by MNR's Fish and Wildlife Branch to compare bioenergetics of Lake Whitefish growth before and after the invasion of zebra mussels and spiny water flea will assess food web interactions. Under NOAA's lead, in cooperation with Michigan's Department of Natural Resources, and the U.S. Fish and Wildlife Service, MNR is contributing to an examination of the diet, condition and growth of Lake Whitefish in various regions of the lake. These variables will be examined relative to abundances of Diporeia. The study will also compare whitefish in locations of Lake Huron with and without diporeia to determine the potential lakewide effects of declines of this benthic invertebrate.

7.1.3 Activities Addressing Fish and Wildlife Habitat/Populations

The following projects are underway to assess status and trends and take action on restoring and protecting habitat and populations in the Canadian portion of the Lake Huron basin:

- Summary report on wildlife populations and habitat
- Assessment and protection of fish habitat and populations in selected nearshore, coastal and spawning areas of Lake Huron
- Barriers to fish movement project
- Watershed rehabilitation and protection projects in the Ausable, Bayfield, Maitland, French and Manitou Rivers, Huronia Area tributaries and Blue Jay Creek.

A report entitled "Current Status, Trends and Distributions of Aquatic Wildlife along the Canadian Shores of Lake Huron" is in the final stages of preparation by Environment Canada and will assist in targeting high priority areas for protection and restoration in the watershed. Fish community and habitat assessments are underway in many areas of the lake by MNR's Lake Huron Unit and various district offices. A nearshore small fish community and exotic species assessment is being conducted lakewide and will evaluate the status of native populations with a comparison to populations of round goby. In Georgian Bay and the North Channel, walleye spawning habitat is being inventoried and assessed. The identification and GIS mapping of Lake Trout and Lake Whitefish spawning shoals and their assessment will aid in habitat protection and better stocking practices. Lake Sturgeon spawning locations are being identified to determine what rehabilitation efforts are needed and if current harvest levels are sustainable.

Various wetlands in coastal and river delta areas along the Canadian shore of Lake Huron are being measured for a broad set of physical, chemical and food-web characteristics by researchers from McMaster University in cooperation with MNR and EC. The work will lead to the development of biotic indicators of wetland health and relate to anthropogenic disturbances.

Satellite imagery and various other assessment techniques are being applied in important coastal wetlands (Central Algoma, Southern Lake Huron and Georgian Bay) under several projects which support the need for current and accurate information on which to base management decisions for habitat enhancement and protection. A project to identify and map barriers to fish movement in tributaries to Lake Huron in the Maitland, Nottawasaga and Severn Sound areas have contributed to a binational GIS project for Lake Huron and will assist in identifying areas where stream habitat can be improved through dam removal.

Projects underway by MNR's district offices are targeted to local watersheds in the Canadian side of the Lake Huron basin. These projects assist rural landowners in addressing sources of contaminants and erosion on their properties and encourage best management practices through river clean-up, plantings, establishing buffer strips, stream rehabilitation, managing nutrients and drainage. A key component of these projects is to inform, educate and influence sound stewardship practices on the landowner property which will result in improvements to water quality and fish habitat.

In addition, the Lake Huron Lake Committee under the Great Lakes Fishery Commission have a number of activities underway which support the goals of the Lake Huron Binational Partnership:

- Fish stocking
- Sea Lamprey control

- The Development of Environmental Objectives supporting Fish Community Objectives
- Commercial and sport fish assessment projects
- Lake Huron Stewardship Councils

The Great Lakes Fishery Commission and the Lake Huron Lake Committee and Technical Committee have an established binational forum and process for addressing issues, research needs and management actions required to protect and enhance the Lake Huron fish community. The Commission coordinates the Sea Lamprey Control Program for all of the Great Lakes and includes the use of lampricide, barriers to prevent spawning, traps to remove females, sterilizing males and research. Between seven and thirteen million fish a year are stocked by the Michigan Department of Natural Resources, the U.S. Fish and Wildlife Service and the Ontario Ministry of Natural Resources. Three to four million of these stocked fish are lake trout and walleye aimed specifically at rehabilitation efforts.

The development of Environmental Objectives will address the need for habitat protection and enhancement to meet the abundances and species makeup desired for the lake, while ongoing annual assessments of the commercial and recreational fisheries provide essential information for maintaining the sustainability of the resource. Two Stewardship councils are supported to assist MNR in making management decisions related to the fisheries of Lake Huron.

7.1.4 Activities Addressing Nutrient and Bacteria Issues

Projects underway or planned to focus on the bacterial contamination and algal fouling of beaches along the south-east shore of Lake Huron include:

- Water quality surveys at nearshore index/reference stations
- Lake Huron south-east shore project
- Best Management Practices Compliance promotion activities
- MOE/OMAF Science Committee

Seventeen Lake Huron/Georgian Bay monitoring stations in the Great Lakes-wide suite of index and reference stations were surveyed in 2002 and 2003 by the Ontario Ministry of Environment as part of their long-term monitoring program. This data allows for temporal and spatial comparisons for Lake Huron and throughout the Great Lakes and connecting channels. This information will be compiled and used for overall evaluations of status and trends of conventional parameters as well as contaminants in water, surficial and suspended sediment.

The federal/provincial south-east shore working group has a workplan for a number of monitoring and research projects which will continue over several years. Partners in the working group include Environment Canada's regional staff and National Water Research Institute, Ontario's Ministries of Environment, Agriculture and Food, Natural Resources. A background summary of water quality monitoring information, complaints and beach posting information was prepared by the Lake Huron Centre for Coastal Conservation for Environment Canada. Specific research projects are aimed at microbial source tracking, and the influence of tributaries, groundwater, swash zone, wildlife (specifically birds), algae and beach management practices on E.coli levels on beaches. A more focused short-term approach will be followed by the MOE/ OMAF Science Committee to examine sources of bacterial pollution in Huron County focusing on areas of shoreline which have been posted on a regular basis in recent years due to levels of the indicator *E.Coli.* in water.

The Nutrient Management Act, enacted in Ontario in June of 2002 is a comprehensive, province-wide approach to nutrient management designed to protect soil and water quality in Ontario's rural communities by establishing regulations which are being phased in over time. However, in the meantime, best management practices are being promoted in the agricultural community through various techniques by responsible agencies (OMAF, MNR, Environment Canada and Conservation Authorities). Many of the

province's top watersheds that have experienced the greatest impact from livestock operations are in the Lake Huron basin (Blackie and Tuininga, 2003).

7.1.5 Activities at Areas of Concern

7.1.5.1 Spanish Harbour

The following activities are in support of tracking the recovery and ensuring ongoing management of the AOC:

- Spanish River Delta Fish Community Assessment
- Whalesback Channel Integrated Management Plan Initiative
- Spanish Harbour Restoration of Muskellunge Population
- Sediment and Benthos Assessment

Fish community assessments by MNR's district office in Espanola will gather and collate a database of existing fisheries data and measure the progress of fish community recovery. In addition, MNR will work with First Nations and stakeholders in the development of a comprehensive integrated management plan for species of recreational, commercial, and priority aboriginal food fishing interest in the Whalesback Channel. The muskie re-introduction work which has been ongoing for a number of years within the AOC will be evaluated now that the project has reached completion.

The National Water Research Institute (EC) conducted detailed sediment and benthic assessments in the AOC in 2003. The results of this work will be combined with recent data collected by MOE and used to assess the progress of natural recovery of contaminated sediment. A modeling exercise will assist in making predictions about when the AOC will have met the goals and can be delisted.

7.1.5.2 Severn Sound

As a condition of delisting, MNR is completing (in 2004) a detailed analysis of the Severn Sound fish community, with emphasis on the walleye population and with assessments of small fish and exotic species. The Severn Sound Environmental Association also plans to meet the final delisting commitment in 2004 through a project to ensure the recognition and implementation of Fish Habitat Management Plans by its member municipalities and their inclusion in official plans.

7.2 U.S. Watershed

Over the past two years, Federal, State, Tribal, and local agencies have made considerable progress toward protecting and restoring the Lake Huron watershed. Persistent, bioaccumulating chemicals have been removed from the environment, populations of native species show signs of recovery, and communities are actively managing land-use to protect natural resources. Several highlights from major projects are provided below.

7.2.1 Addressing Contaminated Sediments in Areas of Concern

Some harbors and rivers within the Lake Huron watershed continue to be contaminated by the legacy of industrial pollution. Several programs target contaminated sediments for removal, before the sediments are dispersed by storm or flood events. The recently-passed Great Lakes Legacy Act (Public Law No: 107-303) may help advance ongoing efforts. The act authorizes appropriations up to $50M per year from FY2004 through FY2008 to address contaminated sediment projects in Great Lakes Areas of Concern.

7.2.1.1 Saginaw Bay

Following the removal of about 345,000 cubic yards of contaminated sediments from five areas in the lower Saginaw River, Michigan Department of Environmental Quality and the U.S. Fish & Wildlife Service

continue to implement post-dredging activities and monitor ecosystem recovery. These activities are pursuant to a 1998 $28.2 million natural resources damages settlement [under Superfund].

Michigan Department of Environmental Quality and U.S. EPA – Great Lakes National Program Office are performing surveys of the horizontal and vertical distribution of dioxin/furan concentrations in the Tittabawassee, Saginaw, Cass, and Shiawassee Rivers. While PCB contamination has been well documented in this area, dioxins and furans have not. This project is funded through U.S. EPA- GLNPO's competitive grant program and has received strong support from the U.S. Fish and Wildlife Services, as it will complement USFWS ecological risk assessment for dioxin like compounds in this watershed. The Service plans to ultimately use these study results to calculate congener-specific sediment to biota accumulation factors. The assessment is expected to be completed by 2005. Meanwhile, MDEQ has completed an aquatic ecological risk assessment for the Tittabawassee River and is working with Dow Chemical (under RCRA) to implement interim actions to protect human health while they develop plans for corrective actions to address the dioxin and dibenzofuran contamination in the Tittabawassee River and its floodplain.

Michigan Department of Environmental Quality and U.S. EPA Region 5 are continuing the DDT/PBB Pine River sediment cleanup and post-evaluation. This effort is funded through the Clean Michigan Initiative and Superfund. Total project cost to date is $53 million. To date, about 400,000 cubic yards of DDT contaminated sediment has been removed (which includes approximately 750,000 lbs. of DDT). About 280,000 cubic yards remain. The clean-up to be completed by the end of 2007.

7.2.1.2 St. Marys River

U.S. EPA - GLNPO and Lake Superior State University is investigating possible downstream contamination of sediments at two focus areas with St. Marys River: the Little Rapids area, a candidate for restoration of open rapid habitat, and Munuscong Lake in the lower St. Mary's, which has undergone substantial hydrological manipulations in the past. This project was funded through U.S. EPA – GLNPO's competitive grant program. The assessment is expected to be completed in 2004.

7.2.2 Partners in the Restoration of the Lake Huron Fishery

Federal, State, and Tribal agencies, in partnership with their Canadian counterparts, manage the open water fishery for the public. Several focused efforts are helping restore native species and maintain the sustainable productivity of the open waters.

7.2.2.1 Lake Trout Rehabilitation

The U.S. Fish and Wildlife Service, Michigan Department of Natural Resources, Ontario Ministry of Natural Resources, and the Chippewa Ottawa Resource Authority participates in the interagency effort to restore lake trout to self-sustaining levels in Lake Huron. Supplemental lake trout stocking in U.S. waters of Lake Huron is conducted primarily by the USFWS' National Fish Hatcheries. Fall spawning surveys at offshore reefs in the Six Fathom Bank and Yankee Reef complex monitor natural reproduction that occurs at those sites. The overall rehabilitation effort is tracked by analyzing data collected through interagency fishery assessment activities.

7.2.2.2 Lake Sturgeon Restoration

The U.S. Fish and Wildlife Service, in partnership with the Michigan Department of Natural Resources, has led an interagency effort in the Lake Huron – Lake Erie region of the Great Lakes to determine the status and trends of surviving lake sturgeon stocks. This effort has relied on cooperation from state, tribal and provincial commercial fishers to collect measurements and externally tag by-caught sturgeon, allowing the assessment of movement and distribution. Additional research includes the genetic analysis and profiling of spawning stocks from numerous Great Lakes tributaries, including one of largest known spawning sites in the St. Clair River.

7.2.2.3 Monitoring the Growth and Condition of Lake Whitefish

The National Oceanic and Atmospheric Administrations' (NOAA) Great Lakes Environmental Research Laboratory, in partnership with MDNR, USFWS, and OMNR, is examining the diet, condition, and growth of lake whitefish in various regions of the lake. These variables will be examined relative to abundances of the amphipod Diporeia. This important food organism is now declining and completely gone from many lake areas (see "The Lower Foodweb" below).

7.2.2.4 Managing the Lake Huron Treaty Fishery

Working with the Chippewa Ottawa Resource Authority, the Alpena Fisheries Resource Office (FRO) Treaty Fishery Unit fulfills Department of Interior and Service federal-tribal trust responsibilities by conducting activities in support of the Year 2000 Consent Decree, a 20 year fishery allocation for 1836 Treaty waters between the federal government, state of Michigan, and 5 Native American tribes. The Treaty Fishery Unit conducts fishery assessments in Lake Huron, annually performs statistical-catch-at-age modeling to determine safe harvest limits of lake trout and lake whitefish in 1836 Treaty waters, and provides technical assistance to tribal and state resource agencies.

7.2.2.5 Monitoring Fish Community Health

The U.S. Geologic Survey's Great Lakes Science Center conducts annual bottom trawl surveys at several locations in Lake Huron to determine the abundance, size and age structure of key prey species community composition, and prevalence of exotics. Fish collections are also sampled for analysis of contaminants, energy density, genetics, epizootics, and coded wire tags (lake trout). Fish community assessments are expanding, with hydroacoustic studies of the pelagic community beginning in 2004, and planned additional sampling of lower trophic levels in conjunction with fish surveys.

7.2.3 Targeting the Saginaw Bay Aquatic Ecosystem

Saginaw Bay is one of the most biologically productive portions of the U.S. Lake Huron watershed. Several efforts are advancing the restoration of this critical region. Two are highlighted below.

7.2.3.1 Walleye Recovery in Saginaw Bay

In 2003, the MDNR Fisheries Division presented the Saginaw Bay Walleye Recovery Plan to stakeholders for their approval and endorsement. The Saginaw Bay Walleye Recovery Plan is a science-based blue print for management actions intended to achieve a self-sustaining walleye population and restore ecological balance to the fish community. Biological benefits from the recovery plan are anticipated to extend to the greater fish community, including yellow perch. The recovery plan focuses on 1) reducing stream habitat and sediment delivery to the bay, through collaboration with partner agencies such as MDEQ and the Natural Resources Conservation Districts as well as stakeholder watershed groups, 2) achieving fish passage at key dams, 3) reef rehabilitation, and 4) increased stocking of fingerling walleye (to 2.8 million) to shift the predator/prey balance. This effort is closely linked to the effort described below.

7.2.3.2 Restoring Fish Passage to Saginaw Bay Tributaries

A pilot project is currently investigating how to restore natural flows and enhancing fish passage over low-head barrier dams in the Saginaw River watershed. A decision-making tool and strategy for resource managers and communities that will identify the most cost-effective options for dam removal/fish passage to achieve the targeted, sustainable fish population goals for Saginaw Bay. In cases where dam removal is unlikely in the near-term, a design feasibility study will identify techniques for enhancing fish passage over a barrier dams. This effort, organized by Public Sector Consultants, includes the following project partners: The Partnership for the Saginaw Bay Watershed, Michigan Department of Natural Resources, City of Frankenmuth, Michigan Department of Environmental Quality, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and community representatives. This project could provide a template for fish

passage on other Great Lakes tributaries.

7.2.4 Wildlife and Habitat Management

7.2.4.1 The Great Lakes Piping Plover

The USFWS and its partners continue to implement a program aimed at recovering the Piping Plover on federal, state and private lands. The U.S. Fish and Wildlife Service (USFWS) is estimating the total number of nesting Piping Plover pairs, eggs laid, eggs hatched and chicks fledged. This information will help determine cause of mortality of eggs, chicks, and/or adults, as well as implementing and evaluating protection/recovery strategies. Ultimately, the effort will lead to recommendations to improve nesting success, long-term plover population persistence, and population recovery. USFWS also partners with the State of Michigan to provide educational/information materials on coastal ecosystems and the rare, threatened or endangered species that inhabit them. The focus of the program will be on the protection the federally endangered piping plover and its nesting habitat on Michigan State Park lands through managing state lands during the nesting season and educational programs about the nesting piping plovers and the importance of coastal ecosystem processes.

7.2.5 Understanding the Lower Food Web

All fish species rely on the small organisms of the lower aquatic food web, especially during the first few years of growth. The small shrimp-like organism called Diporeia is an important food organism for Lake Trout and Whitefish. Data suggest that Diporeia now declining and completely gone from many lake areas. Scientists are investigating these changes, as described below.

7.2.5.1 Benthic Macroinvertebrate Community of the Open Waters of Lake Huron

The Great Lakes Environmental Research Laboratory, NOAA, in partnership with OMNR and NWRI, are conducted a benthic macroinvertebrate survey in the main basin of Lake Huron in 2003 to determine trends in major macrobenthic groups. Many of the 80 sites sampled were also sampled in 2000. Of most interest are changes in abundances of the amphipod Diporeia and dreissenids (zebra and quagga) mussels.

7.2.5.2 Changes in the Lower Food Web of Saginaw Bay

The Great Lakes Environmental Research Laboratory, NOAA conducted a large study in Saginaw Bay between 1990 and 1996 to assess the impact of the zebra mussel on the lower food web (nutrients, phytoplankton, zooplankton, benthos). While a portion of the data has been analyzed and published, present efforts will complete the analysis and provide an overall synthesis.

7.2.6 Monitoring the Threat of Invasive Species

The Eurasian Ruffe continues to be found around the Alpena area and has the potential to become a significant component of the fish community. The expansion of the range of this species has been closely monitored over the past decade. Since 1992, the U.S. Fish and Wildlife Service has conducted annual surveillance to monitor Aquatic Nuisance Species (ANS) and population trends of nearshore fish community at Lake Huron ports, river mouths, and in the St. Marys River. These efforts monitor the existing fish community, track the effects of the Eurasian Ruffe, and provide early warning of new ANS populations.

7.2.7 Community Planning Efforts

Communities are expanding their efforts to incorporate natural resource management efforts in their land-use planning and zoning laws. One recent effort is highlighted below.

7.2.7.1 The Misery Bay Initiative, A Plan to Protect Coastal Ecosystems

The Northeast Michigan Council of Governments, is helping Alpena-area governments establish protections for nearshore terrestrial ecosystems through a coordinated planning effort. The partnership, partially-funded through U.S. EPA- GLNPO's competitive grant program, includes governmental agencies, local government, land owners, industries, and conservation organizations. The process will include assessments of existing conditions, review of local planning and zoning, analysis of threats to ecological values, and development of strategies for resource protection. This project will continue through 2004.

7.2.8 Improving Data Management and Sharing

7.2.8.1 Lake Huron GIS

Agencies are continuing to investigate way to use technology to enhance management efforts. The Lake Huron "geographic information system" decision support tool developed by Michigan Department of Natural Resources has helped quantify connectivity issues, target habitats for restoration and protection, and build public support for management actions. Hundreds of spatial data layers have been integrated into the GIS system, including biological data (e.g., fish and bird data including invasive and threatened species); base layers (e.g., political boundaries, nautical charts, and management units); classifications for tributary, terrestrial, and wetland habitats; and environmental layers (e.g., areas affected by fish contaminants, areas of concern, locations of remedial action programs). Data layers have been structured to accommodate all levels of GIS users.

7.2.8.2 Bald Eagle Monitoring Database

In cooperation with Michigan State University, USFWS personnel are now using the state-wide bald eagle database created by the University's Department of Fisheries and Wildlife. The USFWS serves as the primary clearing house for all bald eagle data records in the State of Michigan and the new database assists in ensuring accuracy and validity of existing and newly added data from around the State. The project provides the USFWS with additional organization and accuracy of bald eagle records and georeferencing assistance.

7.2.8.3 Improving Coastal Wetland Restoration through a Conservation Lands Inventory

Through U.S. FWS support, Ducks Unlimited and is creating a comprehensive GIS layer of Conservation And Recreation Lands (CARL) for the Lake Huron watershed (as part of a project spanning five of the Great Lakes States: Wisconsin, Michigan, Illinois, Indiana, and Ohio). The CARL GIS layer will consist of public lands (Federal, State, and locally owned lands), private lands (The Nature Conservancy, Audubon, and local conservancies) and conservation easements (Wetland Reserve Program, Conservation Reserve and Enhancement Program, etc.). By creating the CARL layer for the five Great Lake States with DU, the U. S. Fish and Wildlife Service provides a valuable tool for planning and development of coastal and inland wetland habitat restoration and protection activities. The CARL layer will also assist other land-use planners by formulating informed decisions, including plans for Greenways, conservation, and recreational activities.

7.2.8.4 Ranking System for Great Lakes Islands

Developed by the U.S. Fish and Wildlife Service, this tool uses a database and short narrative to rank islands to achieve conservation goals. The narrative include an executive summary, description of the methods, list of information sources, etc. The database ranks islands categorically by such variables as presence/absence of threatened & endangered species, nesting waterbirds, use by migrating passerines and other birds, presence of building structures, contaminants, fish habitat, etc. Other variables include

geographic location, vegetation type present, and land ownership. The database is searchable by lake, state, and by distance from other geographic features.

7.3 Long-Term Projects

As we look to the future, the year 2007 has been tentatively identified for the comprehensive monitoring and analysis of the health of Lake Huron. This year appears to work well for existing monitoring schedules, although much more work will be necessary to coordinate monitoring on this geographic scale. This topic will be on the future agenda of the Lake Huron Binational Partnership.

7.4 References

Blackie, M.M. and Tuininga, K.A., Prioritizing watersheds threatened by manure spills and manure mismanagement. Environment Canada, internal report. August 2003.

Lake Huron Binational Partnership

Action Plan